The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 13. OCTOBER, 1911. No. 118.

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.

LIST OF SECRETARIES—

General Secretary: J. E. H. Allbut, "Meadow Lea," Highfield Road Stretford, Manchester.

Manchester: H. Sherburn, Rotherwood, Stockton Heath, Warrington.

Birmingham: George Hailstone, 97, Katherine Road Warley, near Birmingham.

Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd. Globe Foundry, Cardiff.

Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.

Glasgow: J. A. Ewen, 124, Pollok Street, S.S., Glasgow

London: T. Murphy, 21a, Brooksby Street, London, N

Contents.

	PAGE
Notes and Comments	569
The British Foundrymen's Association; London Branch	570
Valve Castings and Effects	571
The "Stock" Oil-fired Converter	572
Waste Foundry Sands	576
Separating Iron from Rubbish in the Foundry	577
Progress in Heated Foundry Mixers	581
The Pattern Shop Apprentice	582
Briquetting Metal Borings	583
Cupola Melting Practice	585
Steel Foundry Practice	587
Foundry Buildings	588
Unconsidered Trifles Connected with Foundry Work	589
Cupola Linings, Fluxes and Slag	590
The Keith-Blackman High-Pressure Blower	595
The Prevention of Industrial Accidents	596
Institute of Metals	597
Non-Ferrous Metals in Railway Work	599
Method of Making Match Plate	601
Foundry Plant and Equipment	602
Pneumatic Sand Sifter	602
An American Disc Grinder for Pattern Makers	602
Time Recorders for Works	603
"F.T.J." Bookshelf	606
Inventions	607
Trade Talk	608
Personal	612
New Companies	612
Prices of Metals	614
Deaths	614

Forthcoming Event.

NOVEMBER 10.

British Foundrymen's Association (London Branch).—"Physical Properties of Cast Iron," by F. J. Cook.

NOTES AND COMMENTS.

The Lessons of the Turin Exhibition.

International exhibitions are no novelty at the present time, for the last few years have seen quite a number in different parts of Europe. But the familiarity with which one comes to regard such concerns is liable to dim the significance of some of the features which point important morals to the industrial world. Great Britain, in company with other great industrial nations, is represented by a rather imposing array of exhibits, amongst which, of course, iron and steel and engineering work are prominent, and it is in connection therewith that one lesson is to be learned. We understand, though it has not been officially announced, that British exhibitors have taken quite the lion's share of awards; in fact, "Grand Prix, Turin," will be displayed by a good many of our firms at the close of the Exhibition. We have competed successfully with German, French, and Italian makers in most of the industries represented. But what of the business resulting from the Exhibition? In some cases, we believe, this has been fairly good, though it is where the high-quality article is appreciated that we have done the best. Take, for example, agricultural machinery—a class of product that is more in demand in Italy than are many other engineering products; here the quality of British workmanship is becoming better appreciated, and though the actual orders booked at the Turin stands may not be large, the knowledge is being spread amongst users that our machinery stands in the front rank, and good effect is sure to be experienced before long. The same applies to machine tools (only two or three British firms are showing), in which several of our makers have been doing good business of late years in Italy. There is important competition to be faced from Italian makers, but only in the cheaper classes of machinery; while the first-class British machines are making steady headway. All along the line the same thing occurs—quality tells; and where business acumen has been coupled with good production the results have been favourable. British oil engines, particularly, we believe, have been well received.

So much for the business side. But there are other matters that bear inspection in the light of their relation to our industrial systems. What is the present position of Italy in the iron and steel trades, and what are her possibilities? That she does not rank amongst the first nations must be at once admitted; but as regards the future and its possibilities this is another matter. Italy has for many centuries harboured the metallurgical crafts, though her history during the last couple of hundred years has not been such as is conducive to great industrial expansion. Her natural resources of iron-ore are somewhat meagre, and though the Elban deposits have for years been held in high esteem and now supply several works, the reserve of ore in Italy is not great. Nor

are her coal resources any better; but as she is increasingly utilising her natural waterfalls for power production, and is also in close touch with Continental oil-fuel supplies, the coal question is not of such importance as might otherwise be the case. It is not surprising, then, to find the Italian iron and steel industries expanding, and to witness the rise of several first-class works at various centres. Turin, for example, has something like 20 motor-car concerns, first of which may be classed the famous F.I.A.T. works. (The rise of this firm, in fact, is a striking example of the possibilities before the nation.) It is not, however, to be expected that Italy will rise to the front rank as an iron and steel country; but she may, if she will, so develop her engineering trade that she will lift herself far above the present level amongst the nations. The national ambition to supply all her own shipbuilding and armament equipment is well on the way to fulfilment, thanks to the development of the Terni works, its associated concerns, and other undertakings of a like character—in the development of which, it may be mentioned, British co-operation was an important factor. A glance round the Turin Exhibition indicates clearly that the skill of the Italian craftsman is not to be despised. Abundant evidence of engineering skill is afforded, while in the direction in which our readers are particularly interested, *i.e.*, foundry work, a high standard has already been reached. There is a selection of large bells on view which are fine models of non-ferrous founding, both as regards detail and finish, while in iron and steel the show of foundry products is quite imposing.

Italy's Restrictions.

What, now, of the factors that will have to be combated in the development of Italy's industries, particularly engineering? Probably the most serious of these is the lack of education throughout the country; for, though some would-be dictators of national affairs are for ever predicting evil as the result of educating the working classes, it is admitted by all sound economists that the better educated and more intelligent the individual worker is, the greater is the chance for national progress. The ignorance of the lower class Italian is accompanied by a superstition that is, in English minds, associated with the Middle Ages, and this factor alone is a serious one, which will take a long while to overcome. The industrial centres are not so much affected, since industrial progress has, as its essential accompaniment, a broadening of the national mind. But the masses to which Italy must turn to support any rising industry are, at the moment, gravely ignorant. It is only during the last few years that even the landed proprietors of the country districts have begun to realise the value of modern machinery. Italy, then, must turn her attention to national education before she can do justice to her inherent potentialities; though at times it appears as though this necessity is being overlooked. It is beyond our province to discuss political matters generally, but it may not be out of place to comment on the ill-advised hankering after the expansion of territory that Italy is now displaying, regardless of the huge cost it must inevitably entail for little actual advantage. Far better would it be to turn attention inwards, to the condition of the working classes and the possibility of checking the great flow of emigration to foreign countries of her enterprising sons. There is room for the development of great industries in the country; but so long as the education of the nation's operatives remains at its present stage, so long will Italy lag behind in the race of industrial competition. It is only by increasing the economic value of the unit worker that the nation as an aggregate can progress; and if that improvement is not taken in hand systematically it is proportionately retarded.

The lesson is one that applies in varying degrees to every nation under the sun. Given any conceivable natural resources, a nation will not profit by them until it has become master of them. It may be exploited by other nations, but the status of the people will not be elevated. When, however, the natural resources of a country are not over prolific, it becomes of still greater importance to increase the executive ability of the people as a whole, and industrial and technical education is a preliminary essential to that end. Great Britain, Germany, and America are each, particularly in certain industries, realising the necessity of improving the economic value of their industrial units, and to turn to the conditions obtaining in Italy is to perceive the result of the opposite course of disregard.

The British Foundrymen's Association: London Branch.

The Winter Sessions.

Although the actual programme for the forthcoming winter session of the London Branch of the British Foundrymen's Association has not yet been issued, the matter was under consideration at the Council meeting on Friday, September 22. Judging from the draft scheme the attention of the foundry world will be repeatedly drawn towards London during the coming months.

Two items call for special comment. Professor Turner, Professor of Metallurgy, of the Birmingham University, has promised to lecture before the members on "The Solidification of an Iron Casting in the Mould," while Professor Carpenter, Professor of Metallurgy in the Victoria University of Manchester, has consented to lecture for January 12, 1912. These two lectures will be of very considerable interest to iron-founders, and should certainly prove of high value.

Our congratulations are due to the officials of the London Branch for the inclusion of two such lectures within one session, and it speaks well for the future of the British Foundrymen's Association that this Branch—the youngest offspring from the parent body—should have become so well established in the comparatively short period since its inception.

As regards the monthly meetings of the London Branch, these will be held at Cannon Street Hotel, London, E.C., on the second Friday in each month, commencing on November 10 next, when Mr. F. J. Cook, Past-President of the Association, will contribute an interesting Paper on the "Physical Properties of Cast Iron."

At least six good Papers have already been arranged for, including two or more on non-ferrous alloys, while also included in the session programme are three or more visits to foundries and works round London, particulars of which visits will be published in our next issue. The forthcoming session promises to be a very successful one, in keeping with the tone of the meetings last year when the Branch was formed, and when it was admitted that the response by London foundrymen had exceeded the expectations of the organisers of the gatherings.

In our next issue we shall be enabled to publish full particulars of the forthcoming dinner of the Branch, which, we understand, will be held on December 9, at the Holborn Restaurant, London.

Valve Castings and Effects.

(By A. Napier.)

It is no uncommon occurrence to find in brass-foundry journals inquiries as to the methods of overcoming the trouble of excessive wastage in the casting of valves. Frequently valves will be cast and appear good until tested, when defects and leakage will develop, resulting from weak, porous places at some point. The founder may, and often does, labour under the disadvantage of having his mixture specified, in which case it is necessary to inqurie whether his treatment of the metal, first, is the cause of the trouble.

Some mixtures are more subject than others to the trouble of segregation of particular constituents, and exceptional care is necessary to prevent this feature producing brittleness and weak places in the castings. A slight alteration in the mixture or the accidental introduction of a small amount of an undesirable constituent may lead to a different structure in the alloy, under casting conditions which formerly gave good results. Shrink-holes in the thicker portions of the castings are a defect that should be met by the moulder in the placing and size of the risers, while dross and scum in the metal—a fruitful source of trouble—is a matter for the melter. In view of the extent to which foundry writers have pressed the point of oxidation, it would seem unnecessary to again do more than mention it; but experience shows that oxidation of the metal through improper melting and exposure to the atmosphere and the furnace gases is a daily occurrence. Many defects in valves are directly traceable to careless melting—sometimes to a neglect to take into account, when melting scrap, the loss of certain constituents during previous meltings.

A number of factors may contribute to the production of castings in steam valve work which leak under test. The moulder may be responsible for not gating the mould properly, a very important feature in obtaining sound castings of any description; or, even with a good mould and the correct mixture, if the metal is not hot enough when poured the result will be bad. Overheating, on the other hand, may also cause a large percentage of failures, as oxidation is very liable to result. The shifting of badly set cores is at times responsible, as may be the design of the casting.

It must not, it will be seen, be supposed that a large percentage of failures in valve castings is necessarily due to a wrong mixture. It may be defective design, as seen in designs with too sharp a change in the section between flange and body, or defective moulding which gives a mould too hard or too damp. At the same time, the defects may readily be in the metal, from either of the causes previously mentioned, or the trouble may lie directly in the pouring temperature and the manner of pouring. This was clearly shown by the experiments of Carpenter and Edwards with the aluminium-bronzes (Cu, 91 to 90 per cent.; Al, 9 to 10 per cent.), which were proved to give excellent castings for withstanding pressure. It was found that, in order to obtain the best results, this alloy must be poured slowly and at a temperature not more than 80 degrees C. above that at which it commences to freeze or solidify. But the investigators also laid stress upon the moulding side. This mould must be gated for the metal to enter at the lowest point, *i.e.*, it must be bottom-poured, and the gate should have a well at the bottom, the opening being rather narrow. If a green-sand mould, it must not be too damp, and in the case of a close sand being used it is preferable to dry the surface of the lower part of the mould. Nor must the shrinkage of the metal be neglected, but must be met by the use of risers, particularly in the case of large castings.

When using a mixture that has been proved to be suitable, any defect in the resulting castings may be put down to the treatment of the metal, to the design, or the method of moulding; but often mixtures are specified or tried by founders inexperienced in the particular line of castings, which are not suitable. For high-grade mixtures it is often desirable to use no lead, though the absence of lead entails more labour in the machining process, the metal turning much tougher. The distribution of the lead between the crystals of the alloy gives it a shorter and free-working grain, but at the expense, somewhat, of the strength. A suitable mixture without lead is:—Copper, 90 per cent.; tin, 8 per cent.; and zinc, 2 per cent.

The colour of the castings will be detrimentally affected by the presence of iron in the mixture. Iron is liable to become introduced with the copper, as some brands contain appreciable amounts, or it may enter with remelted scrap or wasters in the form of core-wires, chips, etc. Aluminium, while a valuable addition to a number of alloys, does not seem to give satisfaction with valve mixtures; for it has been found that when added to the latter the castings generally develop weakness, and leak under test. The aluminium bronze quoted earlier would seem to be in a different class; but as a general rule aluminium is considered undesirable.

Often the use of a small amount of some deoxidising constituent will overcome persistent trouble with what should be a satisfactory mixture, but which at times is found to give an excessive number of leaky castings. Take, for example, the mixture: Copper, 86; tin, 7; zinc, 4; and lead, 2; this, while giving a fairly good result, will sometimes give castings with brownish spots that display weakness under test, and leak. The spots are generally on the top part of the castings, and result from dirt in the metal. In this case, the introduction of a small amount of some deoxidiser would generally clear the trouble (say, about 0.5 to 1 per cent. of 15 per cent. phosphor-copper).

There are, of course, a number of mixtures which are in common use for the purpose which are not strictly suitable for valve castings. Yellow brass is sometimes employed, but cannot be used for valve work nearly so successfully as can red metal, the number of leaky castings being much greater. With red metal the bad castings may normally run from 5 to 15 per cent., but with yellow brass it will be very difficult to keep the waste down to the higher figure mentioned.

Some founders give special attention to the wearing parts of valves, an example being the introduction of nickel into valve-seat mixtures, a typical one having the following composition:—Copper, 85 per cent.; tin, 10 per cent.; nickel, 3 per cent.; and zinc, 2 per cent. Monel metal has proved very successful for seats and plungers that are liable to wire-draw.

In passing, it may be as well to draw attention to the importance of good cores for the class of work under consideration; for a bad core, while only costing, perhaps, a very trifle less than a really good one, may readily result in a spoiled casting. The core sand should be burnt sand, beach sand, or similar material, with no constituent that will give off excessive gas when the casting is poured.

The "Stock" Oil-Fired Converter.

Hitherto the economical production of small castings, with a limited output, has presented considerable difficulty in connection with the Siemens furnace, economy of production being only obtainable by the use of a furnace of comparatively large capacity; so that if the plant cannot be kept running on castings alone, a more or less large proportion of ingots must be made, often of a quality for which it is not always easy to find a market. On the other hand, if the system adopted be either the "Tropenas" or "Robert," there is not only the expense of the converter and blower and the necessity of running as many heats as possible uninterruptedly to maintain the heat in the converter, but there is the further expense of cupolas and accessories necessary to the systems and quite independent of the ironfoundry plant.

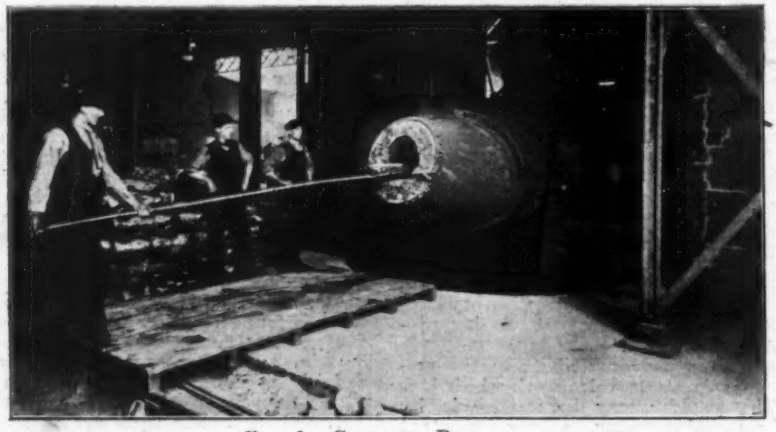


FIG. 1.—CHARGING POSITION.

By the courtesy of the management of the Darlington Forge Company, Limited, Darlington, our representative was recently enabled to see in operation a "Stock" oil-fired converter which, rather more than twelve months ago, superseded two seven-ton open-hearth plants in their foundry for small steel castings, and which appears to have successfully solved the difficulties referred to above. The converter in question is of three tons capacity, and so satisfied are the management with its operation, and the quality of the steel produced in this experimental unit, that they propose to extend the system at an early date. From the steel-producer's point of view the most important feature in favour of the oil-fired converter is that owing to the fact of oil being used as fuel, no impurities are introduced into the metal during the process of manufacture. Another consideration, which is perhaps of little less importance, is that the metal is poured very much hotter; it thus flows with greater freedom, and lends itself more readily to the manufacture of intricate castings.

In Fig. 5 we show a number of castings produced from the steel made by this process. Many of these are sufficiently remarkable to be worthy of study; for example, the goblets, in which the thickness of metal is only $\frac{1}{16}$ in., or the bracket for the radiator, shown in the foreground. This bracket is 32 in. long, the holes having an interior diameter of 2 in., and the flange on the outside being $\frac{1}{4}$ in. The casting itself is $\frac{1}{16}$ of an inch in thickness. The beautiful clean finish on the castings of the motor-cycle hubs, and the reproductions of the fine tracery in the placques are specially noticeable; the whole of the castings shown were made from mild steel of 0.2 carbon. The pneumatic tool chisel shown was also manufactured from tool-steel produced by the process. The cost of production of such tool-steel in the bars was about £16 per ton, as compared with £52 per ton at which it had previously been purchased by the Company.

Fig. 6 illustrates a further set of castings, and shows admirably the range of production. A wheel similar to the one in the centre was tested by dropping through 5 ft., 10 ft., 15 ft., 20 ft., and 25 ft., without developing any sign of fracture. With a drop of 40 ft. one spoke was cracked; this drop was then repeated five times, and the wheel, remaining unbroken, was finally smashed under the ball. A fractured spoke is shown on the top of the centre wheel. The small wheel on the left hand is of manganese steel, and this was distorted cold under a hammer without fracture.

"Stock" Converter Steel—Result of Seven Cast-steel Tensile and Bending Tests. Five Tensile and Six Bend Tests shown in Fig. 7 :—

Test No.	Description.	Original area. Inches.	Ultimate Stress Per sq. in. of original area.	Contraction. Per cent.	Elongation. Inches.	Elongation. Per cent.	Appearance of fracture. Bend 1 in. diam.
1	12 Roof bars	0·50	27·4	54·3	3	30·0	180° N.B. 1 in. sq.
2	4 Radial wheels ...	0.50	28·0	50·8	3	34·0	" " "
3	1 Ford. bearing keep	0.50	28·8	52·3	3	33·0	" " "
4	1 " " "	0.50	29.6	47·2	3	32·0	" " 1 in. diam
5	1 Aft " "	0.50	30.0	52·3	3	32·0	" " "
6	4 Side frames	0.50	29·0	50·8	3	28·0	" " "
7	10 Platform supports	0.50	29.4	51·6	3	30·6	" " "

Fig. 7 shows a number of test pieces which, together with the appended table of tests and analysis, is such as to render comment superfluous.

Analysis.

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.	No. 4. Per cent.	No. 5. Per cent.	No. 6. Per cent.	No. 7 Per cent.
Carbon	0·22	0·22	0·20	0·23	0·23	0·21	0·22
Manganese ...	0·607	0·540	0·600	0·567	0·540	0·607	0·540
Silicon	0·273	0·178	0·237	0·285	0·273	0·273	0·296
Sulphur	0·012	0·019	0·013	0·016	0·010	0·012	0·018
Phosphorus ...	0·020	0·021	0·018	0·029	0·020	0·020	0·025

Fig 8 illustrates a 10-in. valve as cut through for Admiralty test. Whilst the resulting figures are, of course, not obtainable, evidence of their satisfactory nature is found in the fact that the Admiralty have approved the steel produced by the "Stock" system. The test appended is of two similar valves taken at the makers' works.

100-h.p. D.C. motor, 220 volts, 600 r.p.m,, the blowing pressure varying from ¾ lb. to 3½ lbs. per square inch. The blast enters by a main passage through the centre of the bottom plates—so that the converter may be turned round without interruption—by a vertical blast main outside the converter, and then passes through one of the trunnions to the blast box at the side of the converter. The oil burners, which are removable, are placed within the blast box. In addition to the blower a small pump is employed to maintain a pressure of 40 lbs. in the oil-storage tanks, at which pressure it is fed direct to the burners.

The vessel is tipped by a direct-coupled totally-enclosed 10-h.p. motor, which is carried in one of the trunnion housings. The turn-table is also operated by a motor of similar capacity and design, but in this case through an intermediary shaft and bevelled gear. For charging, the vessel is inclined in the horizontal direction, and moved through an angle of 90 degrees. The charging is by means of an ordinary peel, a system which enables the full charge

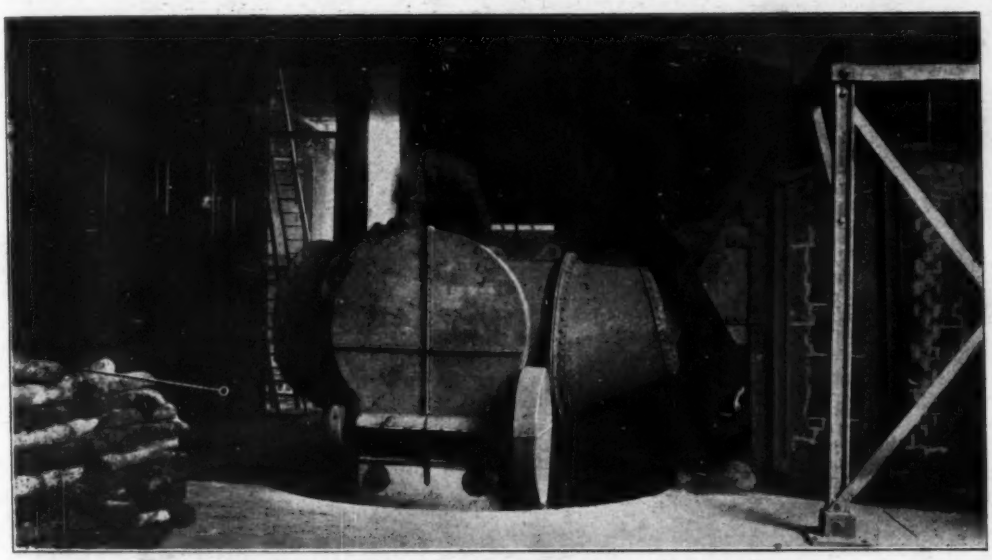


FIG. 2.—THE "STOCK" OIL-FIRED CONVERTER; MELTING POSITION.

Two Tests cut out of 10-in. Stop Valve. Marked Nos. 1 and 2.

Test No.	Description.	Original area. Inch.	Ultimate stress. Per sq. inch of original area.	Contraction. Per cent.	Elongation. Ins.	Elongation. Per cent.
1	10-in. Stop Valve	0.496	27.8	—	3	31.3
2	"	0.250	28.4	53.6	2	37.0 / 36

Analysis: Carbon, 0.22 per cent.; Manganese, 0.508 per cent.; Silicon 0.130 per cent.; Sulphur, 0.014 per cent.; Phosphorus, 0.041 per cent.

The converter vessel, which is lined with ordinary silica firebrick, is mounted on trunnions standing on a steel base-plate, which in turn rests on a roller path in a cast-iron base-plate. This provision allows the vessel to be turned round in the horizontal plane for purposes in the process to be described later. Blast is supplied by a Root's blower with a capacity of 3,000 cubic feet per minute. This is direct-driven by a

of pig-iron and scrap to be put in by three men in rather less than eight minutes. The vessel is now turned in the horizontal position with its nose pointing to the entrance of an economiser. This economiser is an important feature of the plant, serving to recover the waste heat arising from the combustion of the oil during melting. It consists essentially of a series of ribbed cast-iron pipes of U section, through which the blast passes, the heat from the vessel passing round and amongst those pipes on its journey to the chimney. By this arrangement the cold air delivered from the blower is raised to a temperature of about 800 degrees F. before passing to the converter. With the vessel in the horizontal position, the blower is started and the oil lighted by the heat of the walls of the converter arising from a previous blow. The combination of oil and blast produces a temperature of approximately 300 degrees C., melting the charge of iron in about 1½ hours.

So soon as the metal is melted the valve controlling the oil supply to the pressure tank is closed—the pump which runs continuously, delivers during such

stoppage to the main storage tank at a distant part of the works—the burners are removed from the blast box, a simple operation occupying about a couple of minutes, the vessel is then turned into an upright position, and the conversion to steel continued in

FIG. 3.—THE "STOCK" OIL-FIRED CONVERTER; BLOWING POSITION.

the ordinary way; the blast, which for melting was ¾ lb., is now increased to a pressure of from 2½ to 3½ lbs. The blowing process lasts about 20 minutes, when the vessel is moved to the charging position, and the necessary additions of ferro-silicon or ferro-manganese are made. The turn-table is now moved through a further angle of 90 degrees, and the vessel is then in a position for teeming into the ladle.

pushed five heats may be obtained. In practice it has been found possible to obtain from 25 to 30 heats before the lining requires renewal.

Our representative was able to follow through a complete cycle of operations, and to carefully check the consumptions of fuel and energy. The charge of 2½ tons was melted and converted in 1¾ hours with a fuel consumption of 70 gallons, and a power consumption of rather less than 50 kw. It should be noted that as the test in question was taken early on the Monday morning, it is reasonable to assume that still better figures would be obtainable when the vessel had become properly heated up by service. The oil used is the crudest petroleum available.

We append a list of figures showing the cost of production of steel produced in the converter. These costs are based on a production of 52 tons per week working single shift only. It may be said that the electric power is charged at a lower figure than that at which it could be generally obtained through a power supply. On the other hand, the costs of fuel are certainly very conservative, both as regards the quantity consumed and the purchase price. The figures, however, although resulting from carefully tabulated tests, must be considered as approximate, and would, no doubt, vary in each particular case. They are, however, sufficiently striking to merit the careful consideration not only of the steel-maker to whom the economical production of small castings is of vital importance, but also of the foundry manager who finds a growing demand for small castings of malleable iron and steel, a demand with which, if his business is to be maintained and extended, he must be prepared to cope.

The design of the converter is such that it may be built to give the best possible economy, in sufficiently small sizes to place it well within the capacity of even the smallest foundry. Electricity as the driving agent is, of course, merely a choice, and if current could not be procured on reasonable terms, steam could be brought into service, whilst the range of capacities—from 10 cwts. up to 5 tons—should render this type of plant of useful service in even the

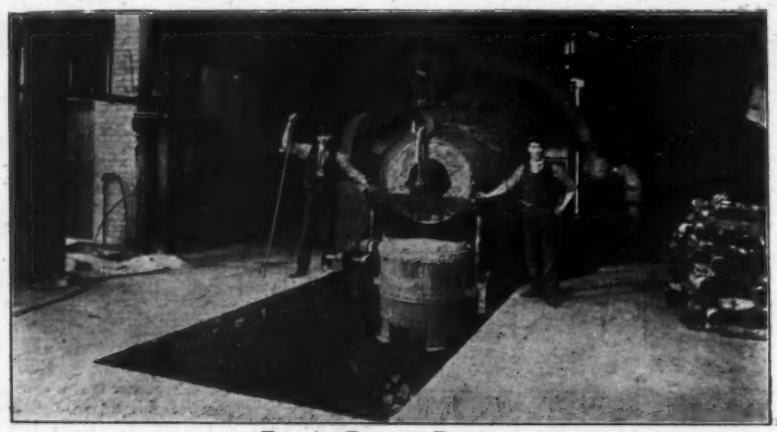


FIG. 4.—POURING POSITION.

A second vessel is retained as a stand-by, so that the necessary repairs to, and renewals of, linings may be carried out without any serious stoppage to the plant, all that is necessary being to lift out the worn and substitute the stand-by vessel. The converter under notice has been working continuously for some 20 months, four heats a day, though if

largest of steel works. The converter under notice was built in its entirety by Messrs. Thwaites Brothers, Limited, Bradford, the motors being supplied by the Sunderland Forge & Engineering Company, Limited. The sole selling agents for Great Britain are Messrs. Caper Robson & Company, Limited, North Road, Darlington.

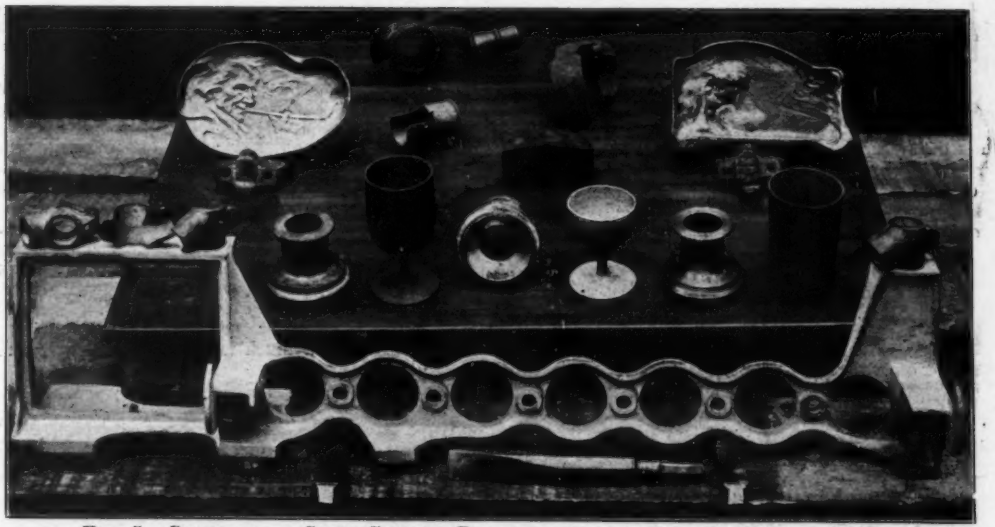


FIG. 5.—SPECIMENS OF STEEL CASTINGS PRODUCED BY THE "STOCK" OIL-FIRED CONVERTER.

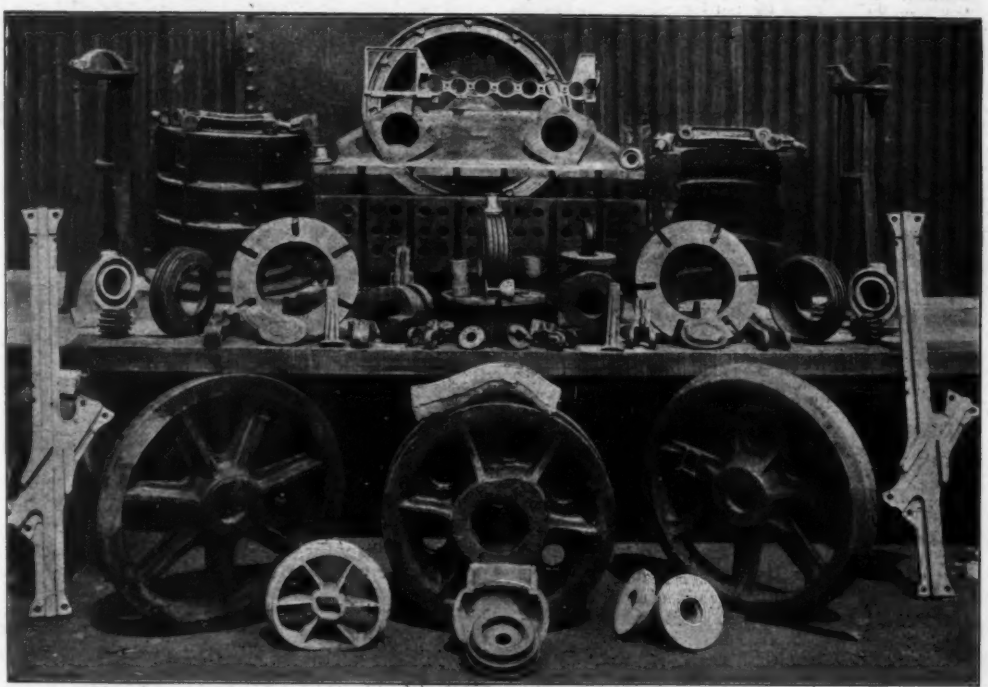


FIG. 6.—SPECIMENS OF STEEL CASTINGS PRODUCED BY THE "STOCK" OIL-FIRED CONVERTER.

FIG. 7.—TEST PIECES OF "STOCK" OIL-FIRED CONVERTER STEEL.

Cost of Steel produced from a 3-ton "Stock" Converter. Based on a Production of 52 Tons per Week, working Single Shift only.

	Per ton £ s. d
Metal and mixings (23 cwts. 3qrs. 10 lbs.)	3 10 2
Fuel oil (40½ gallons at 2½d. per gallon)	0 8 5
Electric power (42 units at ½d. per unit)	0 1 9
Direct wages	0 2 11
General repairs and upkeep, including linings	0 7 0
COST OF CONVERTED METAL	4 10 3
Add allowance for ladle linings and repairs ...	0 2 0
COST OF METAL IN MOULDS	4 12 3
Add allowance for depreciation and interest 0 2 2	
Add allowance to cover royalty charges 0 3 4	
	0 5 6
	£4 17 9

*The cost of the charge is based on the price of hematite being 60s. per ton, and an ascertained loss of 13 per cent. in the process of conversion, and a further loss of 3½ per cent. in ladle skull, pillings and floor scrap.

Analyses of various Steels recently produced by the "Stock" Converter.

CAST-STEEL WHEEL CENTRE, 4FT. 9IN. DIAMETER.

	Per cent.	
Carbon ...	... 0.17	Machined solid.
Manganese	.. 0.40	Tensile test:—29 tons per square inch.
Silicon ...	... 0.17	Bend test:—1 inch square, 180° degrees
Phosphorus	0.05	without breaking.
Sulphur ...	... 0.025	Elongation:—30 per cent. in 2 inches.

INGOT FOR HIGH-CARBON STEEL WIRE.

Carbon ...	... 0.70	Rolled to 5 gauge rod.
Manganese	... 0.40	Drawn to rope wire.
Silicon ...	... 0.01	Stood work well.
Phosphorus	... 0.017	Tensile test:—110 tons per square inch.
Sulphur	... 0.015	

INGOT FOR LOW-CARBON STEEL FOR SEAMLESS SOLID-DRAWN TUBES.

Carbon ...	... 0.08	Tube drawn well and stood British
Manganese	... 0.18	Admiralty tests.
Silicon ...	... 0.011	Tensile test:—23.6 tons per square inch.
Phosphorus	... 0.011	Stretch test:—43 per cent. in 2 inches.
Sulphur	0.01	Bend test:—1 inch square, 18F unbroken.

CARBON TOOL-STEEL.

Carbon ...	... 0.83	
Manganese	... 0.072	Steel forges well and has proved very
Silicon ...	... 0.011	successful for chipping and caulking
Phosphorus	... 0.011	chisels and pneumatic tools.
Sulphur	... 0.011	

HIGH-SPEED TOOL-STEEL.

Carbon ...	... 0.627	
Manganese	... 0.198	Excellent quality for mild-steel forgings
Silicon ...	... 0.059	Tungsten, 5.035 per cent.
Phosphorus	... 0.002	Chromium, 2.012 per cent.
Sulphur	... 0.007	Vanadium 0.190 per cent.

Waste Foundry Sands.

Discoursing on this subject before the American Foundrymen's Association, Mr. S. A. Capron called attention to core-sand washing machines as a practical means of securing economy by cleaning waste core sand and returning a large part of it as a new supply. The washed sand is free from all objectionable substances and satisfactory for use. Not over 20 per cent. of new sand is required to keep the total amount at the same quantity. In operation these machines involve a water process like that of the cinder mill, familiar in modern foundry practice. It is based on the natural separation of sharp sand from any foreign substances, which occurs quite generally in any slowly moving current of water. In these machines the burnt core sand is first submerged in the water, and then by the action of the first series of flanges is made to scour itself. This separates the sharp sand from the burnt core-bond coating that covers the grains. A second series of flanges then takes up the work and effects a further separation of the materials, the different specific gravities assisting in the process.

In its process through the machines the waste is then met by discharge buckets, which pass under the lighter flowing waste and gather up the heavier material, which consists of the reclaimed core sand. The final waste flows out of such a machine as a saturated solution of mud and other foreign matter, including some of the sand which has escaped the discharge buckets. This passes into a two-part settling basin, where a still further separation takes place. From the first partition in this basin is obtained a sand which would be satisfactory for 50 per cent. of the cores in any foundry. The settling in the second partition consists wholly of a very fine ground mud; but this is a very small percentage of the total amount washed, generally not over 1 per cent. This is not only a much smaller proportion than is usually obtained, but is a much less objectionable product to

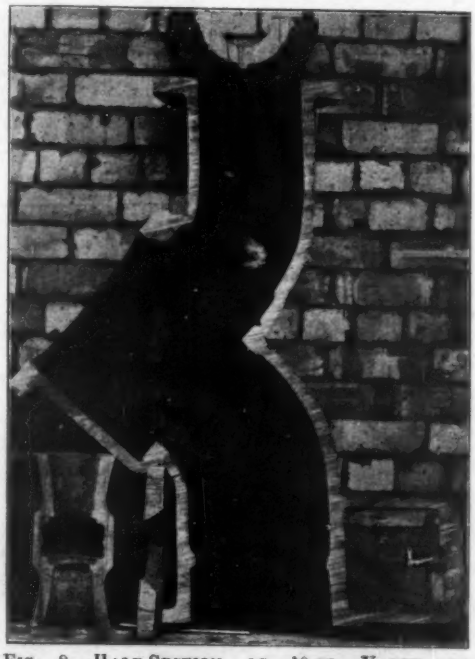


FIG. 8.—HALF-SECTION OF 10-IN. VALVE, OF "STOCK" OIL-FIRED CONVERTER STEEL, CUT THROUGH FOR ADMIRALTY TEST.

dispose of than the ordinary black, dried dust. The waste water can be used over again or carried direct to the sewer. The matter contained in this waste water is so light and fine that it takes several days for it to settle clear, at the end of which time, if the water is turned off and the waste dried, it will be found that 95 per cent. will pass through a "180 by 180" pick silk riddle. In the operation 15 or 20 cub. yards of waste material can be handled in 10 hours. The production of perfect core sand from this amount will vary from 80 per cent. to 90 per cent. The balance is recovered in the settling basin, and brings the total available sand up to about 95 per cent.

WE have received from Messrs. Perkin & Company, Limited, Lord Street Tool Works, Leeds, their new catalogue of machine tools, showing some new models of lathes, shaping machines, grinders and hack-saws.

Separating Iron from Rubbish in the Foundry.

By G. Freimut.

The keen competition of the present day compels both large and small works to devote more and more attention—apart from the question of economical working—to the utilisation of waste products that were formerly neglected. In precisely the same manner as one has learned during recent years to recover, for example, the by-products in coke-oven plants, and make bricks of the waste material in the spoil heaps of collieries and use the same for goaf packing, as well as to convert blast-furnace slag, by granulation, into a useful building material; so also, of late, there has been a noticeable tendency in iron-works, foundries, blast-furnace plants, etc., to recover the iron from the waste products, such as foundry waste, cupola slag, and the like.

For this purpose it was formerly the practice to use permanent magnets, which, however, were attended with the great drawback that their magnetism was neither capable of being regulated nor of being interrupted, and consequently great difficulty was experienced in detaching the magnetic iron from the poles.

Of late, electro-magnets have been employed for separating the fragments of iron from the rubbish, and in this connection mention may be made of the

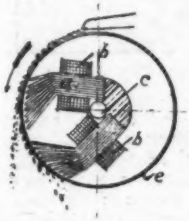


Fig. 1.

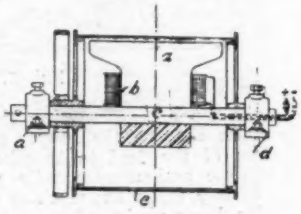


Fig. 2.

iron separator (English Patent No. 5,684/10) introduced by G. Rietkötter of Hagen (Westphalia). In connection with the following description of the apparatus, it may be mentioned that the rights of manufacture in Germany have been secured by the Eisenwerk Neuss A. G., Heerde, near Düsseldorf. The construction of the Rietkötter apparatus is illustrated diagrammatically in Figs. 1 and 2. The system of stationary magnets is formed of two pole cores, each composed of a bundle of mild steel plates, *a*, surrounded by copper coils, *b*, arranged to give opposite polarity. The whole is mounted on a shaft, *c*, firmly secured at two points, *d*. According to the object in view, the shaft with the magnet set can be adjusted at a wider or narrower angle. The individual plates, *a*, of the pole cores are bent, in the form of a secant, toward the cylinder casing, *e*, an arrangement that ensures uniform distribution of the magnetism over the zone destined for the separating process. The casing which rotates about the magnet system is made of powerful iron bars of zig-zag shape, engaging in one another, and secured to a red brass hub rotating on the shaft. In passing by the magnet system the bars of the casing are converted into secondary poles, which retain the iron until it has been carried out of the sphere of influence of the lines of magnetic force. The electric current is supplied through conducting wires, which are led through the hollow shaft, in order to avoid the use of contacts and brushes, these being undesirable in foundry work.

This apparatus meets all the requirements, in respect of reliability and economy, that can be exacted of an iron separator in foundry practice. Casings of thin sheet brass or zinc wear away very soon under the action of the sharp-edged fragments of iron present in foundry rubbish and moulding sand, and also the sharp-edged cupola slag. For the purpose in view, a casing of isolated iron rods is alone suitable, the employment of which in the present instance is rendered possible by the peculiar construction of the magnet system.

In the Rietkötter-Kühn apparatus, a continuous inversion of polarity occurs as the cylinder bars pass by the magnet system, with the result that the iron

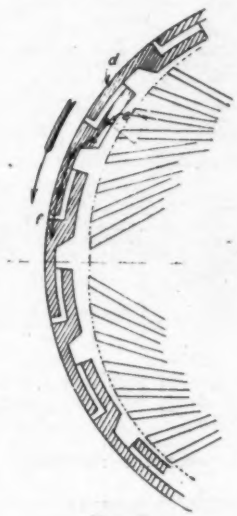


Fig. 3.

retained on the casing is maintained in constant motion, so that it is well freed from sand and is recovered as a pure iron product. The lines of force generated by the electric current employed are able to act to the best advantage, since they run in the same direction as the material to be transported, and all losses by dispersion are prevented by the adoption of suitable precautions; for instance, the use of red brass hubs, etc.

Fig. 3 illustrates a portion of the casing. In consequence of the special section of the bars, *d*, the lines of force are very highly concentrated on the external periphery of the cylinder. The lines of force enter at *e*, traversing the bar in the direction indicated by the arrow, and issuing at *f* to enter the next bar. This arrangement of the casing lowers the magnetic permeability, so that the magnetically separated material drops off easily and certainly.

Fig. 4 shows the arrangement of the iron separator for use with foundry rubbish; the same form may also be used for the concentration of magnetic

ores. For continuous working, the magnet cylinder is fed with material at *a*. As already mentioned, the magnetic material is retained and carried round for a definite distance before being released, whilst the non-magnetic material falls vertically from the cylinder.

These cylinders are made in various dimensions, particulars of which are as follows:—

Type.	A.	A¹.	B.	B¹.	C.	C¹	D.	D¹.
Dia. of cylinder ins., ...	29½	29½	25½	25½	18½	18½	11½	11½
Effective width do. ...	29½	51	21½	41½	16½	35½	15½	26
Capacity per hr. up to, cbc. ft.	460	883	318	600	176	388	106	176
Motive power required, hp.	0.5	0.7	0.4	0.6	0.3	0.5	0.2	0.3
Consumption of energy by magnet. amp. ...	6	6	4	4	2	2	1½	1½
Do. of current by magnet. watts.	700	1400	320	640	170	340	120	240
Weight of cylinder with 2 bearings and 1 belt pulley (see Fig. 4), cwt.	18	32½	13½	21	3¾	7½	2½	4

Direct current is required for the excitation of the magnets, which are, in general, wound for 110 volts.

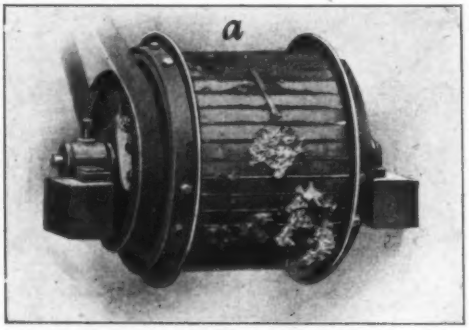


Fig. 4.

The precise output in each case depends on the material to be treated; and the values given in the table are averages.

When smaller quantities of material are to be treated, for instance the rubbish from small foundries, classifying metal turnings in engineering works, etc., the apparatus shown in a complete form in Fig. 5 is used. In this apparatus the cylinder is firmly secured on a framework; above the cylinder is arranged a feed device with eccentric drive, the quick reciprocating motion causing the material to be distributed evenly over the cylinder. In this machine the material to be treated is placed by hand

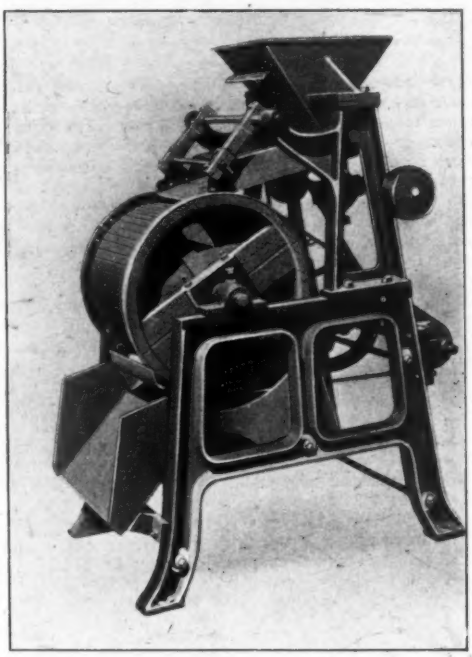


Fig. 5.

in the hopper surmounting the feed device, an adjustable slide on the hopper enabling a partial regulation of the feed to be effected in advance. The magnetic and non-magnetic products are led away separately under the machine by means of shutes.

For large works, where considerable quantities of material have to be dealt with, the arrangement illustrated in Fig. 6 is employed, the feeding device being supplied by an elevator. The machine represented—which is in use at a large works—is mounted

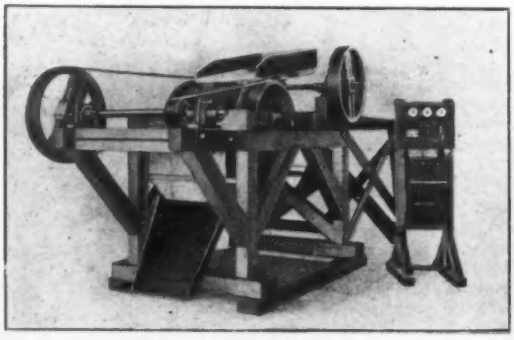


Fig. 6.

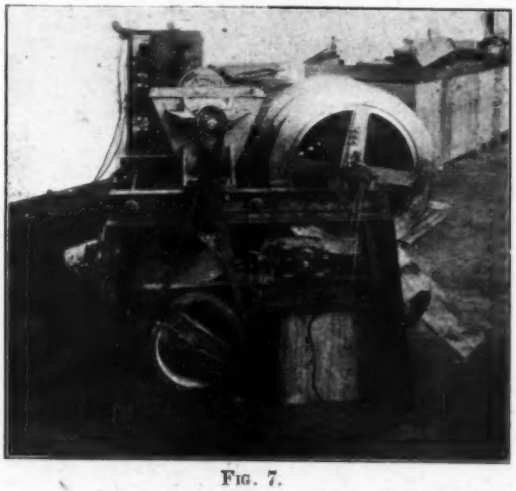


Fig. 7.

on wood. The machines shown in Figs. 5 and 6 are chiefly suitable for dealing with granular materials, containing lumps up to the size of the fist.

Instances are also met with in practice in which the magnetic material is in such a finely-divided condition that it must be reduced to the state of flour to make the yield at all profitable. For the treatment of this floury material the apparatus shown in Figs. 5 and 6 are less suitable than the belt separator shown in Fig. 7. In this separator the material is delivered automatically from a feed hopper on to a belt, which carries the material uniformly past the magnets, the magnetic ingredients of the mass being lifted or attracted on to the cylinder. Arrangements are provided to allow the magnetic material to remain for a certain time in the zone of greatest attraction, in order to enable any accompanying particles of dust to be rejected; it is then removed by means of a special device. Care is also taken to ensure that the product is obtained in the purest possible state. This apparatus has been found highly satisfactory for the separation of particles of iron from the fine flour used in making the carbon rods for arc lamps, etc.

The following description relates to a complete plant for recovering iron from foundry rubbish and ironworks residues, which is installed at the Rothe Erde Works (Aachen) of the Gelsenkirchener Bergwerks A.G. The rubbish under treatment is conveyed by means of an aerial ropeway to the plant, which is situated on the spoil heap below the works. The building is a simple wooden erection, and is equipped with two cylinders, A pattern, with a capacity of about 200 tons per ten-hours' shift.

The material brought by the aerial ropeway is discharged on to a grid in front of the elevator, the large lumps being picked out by hand. The portion falling through the grid is raised to the feed device by an elevator, and is distributed evenly on the separators. The recovered magnetic product passes to a jig screen where it is classified into coarse and fine grades, both of which are delivered into a hopper, from which they are charged into the ropeway skeps for re-conveyance to the works. The falling rubbish is delivered to a separate hopper and transferred to the spoil heap. The plant is driven by an electric motor. The recovered product consists of 21 per cent. of coarse lumps of iron (95 per cent. of metal), and 79 per cent. of finer material containing 91.7 per cent. of metal and 8.3 per cent. of slag.

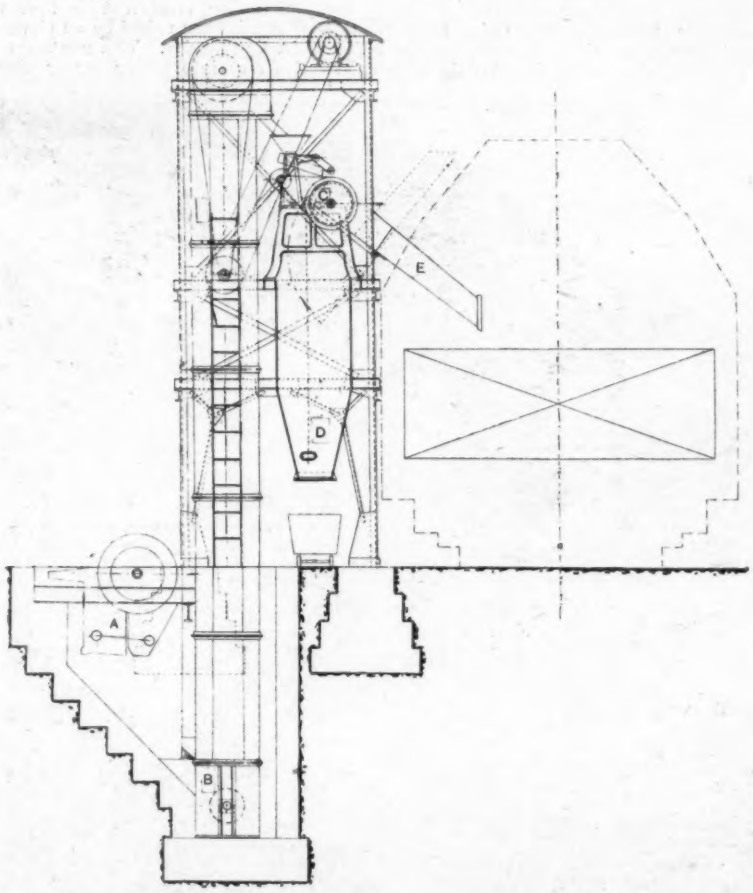


FIG. 8.

The return from such a plant, installed for treating a spoil heap and dealing with ten tons per hour, is shown below :—

Cost of the complete installation	£900	
Yield of iron	7.83 %	
	s.	d.
Daily outgoings, per 10 hours' shift :		
Amortisation and interest on £900, at 20% ...	12	0
Wages, four hands at 4s. 6d.	18	0
Working costs, 7½ hp. at 1d. per hp. and hour	3	0
Oil, cleaning waste and tools	3	6
	36	6

Receipts, based on the price of 40s. per ton of received iron : $\frac{10 \times 10 \times 7\frac{1}{2} \times 40}{100}$ = 331s. 3d.

Net Surplus ... ... 276s. 9d. per day.

Fig. 8 illustrates a separating plant for smaller works. The rubbish, cupola, slag, etc., produced in the foundry, is put through the breaker A, the pulverised material falling into the elevator B, which feeds it to the magnetic separator C.

The magnetic material falls down into the hopper D, from which it is carried away, whilst the dross passes down the shute E direct into trucks. This plant, which is also driven by an electric motor, is capable of dealing with 26 cwt. of cupola slag containing 12 per cent.of iron, 14 cwt. of converter slag, with 20 per cent. of iron, 14 cwt. of converter refuse, with 60 per cent. of iron, 8 cwt. of sandy waste, with 20 per cent. of iron. The yield of iron amounts to 14 cwt.

Value of recovered iron at 40s. per ton :—

Value of recovered iron at 40s. per ton ..	28s. per diem.			
Cost of plant	£200 18s.			
			s.	d.
Expenses per diem :—				
Interest and amortisation at 10%			4	0
Wages, 1 man and 1 youth			6	0
Motive power, 8 hp.			3	3
Oil, tools, &c.			2	0
			15	3
Net profit per diem			12	9

Fig. 9 illustrates a separating plant supplied to August Thyssen & Company, Müheim-on-Ruhr. The material under treatment is first thrown on to a screen, and is then raised by an elevator and delivered to a feeding device. The non-magnetic dross is delivered direct into trucks over a tip-up loading belt.

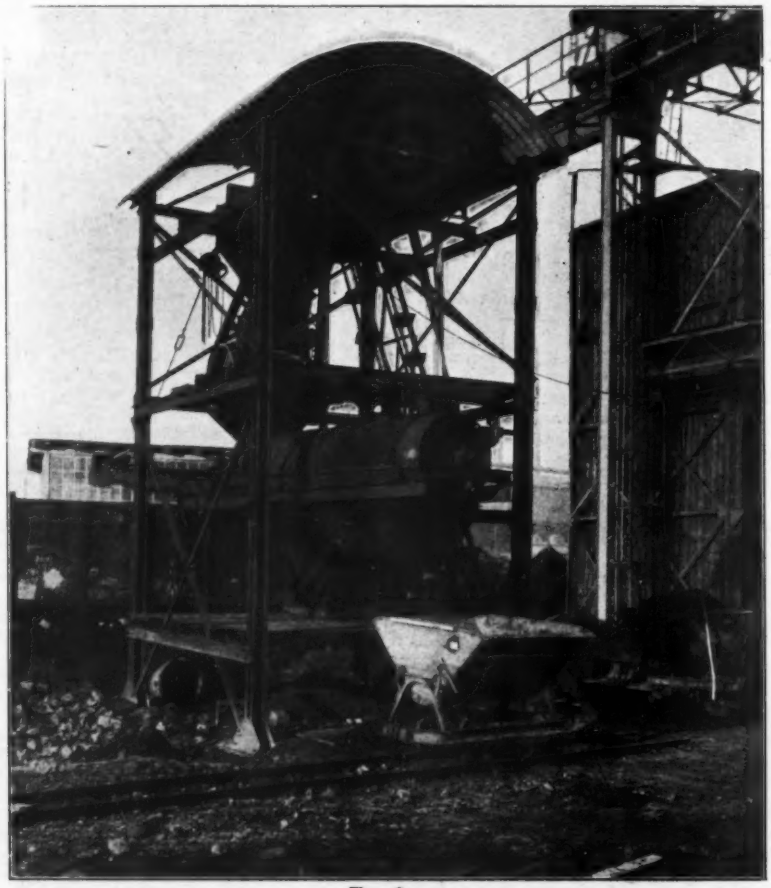


Fig. 9.

The falling iron is classified by rotary screens into coarse and fine grades, which are then removed separately.

The Rietkötter-Kühn separator described above has also been found highly suitable for the concentration of iron ore; but the object of the writer is merely to point out the possibilities before properly designed separating plant for recovering iron from waste products in the foundry.

Progress in Heated Foundry Mixers.*

At the meeting of the Association in June, 1905, the author recommended the use of a heated mixer as an intermediary receptacle placed between the blast furnace and the foundry, into which iron from the blast furnace could be poured, kept liquid for any desired length of time, and its quality corrected by suitable additions of either liquid or solid pig-iron, or by additions of wrought scrap, should it be desired to obtain a metal with lower carbon contents. From this mixer the metal was to be withdrawn whenever needed in the foundry. Its use was more especially recommended in pipe foundries. Since then some progress has been made in that direction, but less in America than in Germany.

Like all modern mixers used in steelworks, foundry mixers are usually in the shape of open hearth tilting furnaces, either enclosed in a round iron shell or preferably, in the more modern ones, with the top of the roof exposed to the open air, for the purpose of keeping it cool and making it more durable. Their heating is mostly done by producer gas, and even in some cases by blast-furnace gas. One regeneration is deemed sufficient for obtaining a good steady temperature. In some cases even, where sufficient proximity allows it, heated air from the blast-furnace hot-blast stoves is recommended, so as to avoid regeneration.

Small Castings and the Mixer.

The question of the use of a foundry mixer becomes more complicated where the iron is destined to be used for small castings, and has to be at a necessarily higher temperature, where the silicon content is allowed to vary only within narrow limits, and where it is desirable to carry the same silicon content throughout. Under such conditions outside additions of a suitable kind will have to be made to bring the metal to what might be called a standard analysis. When, furthermore, the nature of the foundry work is such as to make it unavoidable to keep the liquid metal in the mixer exposed for hours to the action of the flame, some further precautions will have to be taken to prevent the gradual desiliconising of the foundry iron under the action of the flame as well as the slag that may form during the operation. In this respect the operations in the foundry mixer will differ entirely from the operations carried out to-day in the mixer used in connection with open-hearth furnaces. In that mixer partial refining of the metal is contemplated and fostered. In the foundry mixer, on the contrary, desiliconising must be avoided.

Non-Refining Slag.

From the treatment of liquid foundry iron in a furnace, where the writer took precautions against refining of the metal from the first moment onward, it was proved that with the formation of a thin layer of slag of a non-refining nature on top of the liquid bath of metal, foundry iron can be kept exposed to the action of a flame at a high temperature for an indefinite length of time without in any way changing the silicon content of the metal and without deteriorating it in the least. In this respect the writer ventures to state his belief that the metal will rather improve in quality.

Iron running from the blast furnace into a ladle will naturally lose through oxidation some hundredths of 1 per cent. of its silicon content. With only ordinary precautions the loss of that element can be kept well within 0.10 per cent., or not more than will naturally take place with iron running from the blast furnace into the pig-iron moulds. During its transfer from the blast furnace, some of the sulphur and manganese will be eliminated by mutual reaction, the resulting product finding its way into the slag, where together with the silica and some FeO formed, and some other impurities, it will constitute a thin protective slag covering, preventing any further outside oxidation. Pouring the metal from the ladle into the furnace above the slag will form a protective cover over the metal bath in the furnace.

It is not enough, however, to interpose such a layer of slag between the metal and the flame, but it is further necessary to make and maintain the slag of a non-refining nature; otherwise the slag itself would desiliconise the metal much more than the oxidising flame could do it.

The non-refining slag that the writer produced in the first three heats made in the treatment of more than 80,000 lbs. of foundry iron, amounted to less than 500 lbs., and had in its composition:—

	Per Cent.	
SiO_2	= 56.720	
FeO	= 3.605	= 2,805 Fe.
Al_2O_3	= 13.140	
MnO	= 6.700	
	80.165	

The balance was undetermined.

Assuming that half of the Si of the slag is derived from the iron and the other half from the refractory lining, which was only very slightly attacked, it will be found that only 0.08 per cent. of the silicon was eliminated, and this happened mostly in the ladle.

An examination of the analysis of the slag will show that only about 120 lbs. of its weight can possibly come from the iron, corresponding to 0.15 per cent. in weight of the 80,000 lbs. of iron treated as against 4.5 per cent. = 3,600 lbs. less than would have happened in the cupola.

The sulphur and manganese contents of the iron from the mixer are less than the corresponding contents of the iron from the blast furnace. The silicon may be made any desired amount with suitable additions, and once the amount is established it can be maintained without variation for any length of time from the beginning to the end of the cast. But if the iron in the furnace is left exposed to the refining action of the flame and the slag, without taking any precautions against refining, slow desiliconising, that in a special case corresponded to about 0.10 per cent. elimination of that element per hour, will take place. With the necessary precautions against desiliconising, it was found that an iron with 1.90 per cent. Si at the moment of pouring the metal in the furnace, contained 1.86 per cent. of that element after 19 hours of exposure to the hot flame.

By additions of ferro-silicon, the silicon was sought to be increased to 2.30 per cent. while it actually reached 2.28 per cent., at which figure it was maintained to the end of the cast 28 hours after the iron was poured into the furnace.

Advantages of the Mixer.

The advantages derived from the use of the mixer, therefore, comprise the complete avoidance of the loss of silicon and, furthermore, a very notable reduction of

*Read before the Pittsburg Convention of the American Foundrymen's Association, May, 1911.

the sulphur content with a correspondingly slight reduction of manganese from the iron. With some 0.5 to 0.8 of manganese in the iron the sulphur will be reduced by some 10 per cent. to 25 per cent. of its original content, even if the iron coming from the blast furnace contains only 0.03 sulphur or less. Mechanical tests made with the iron from the mixer also show an increase of about 40 per cent. over what the same iron after its remelting in the cupola would show.

The mixer, therefore, greatly improves the quality of an iron that by its treatment in either the cupola or the air furnace would be deteriorated within varying degrees. Owing to this characteristic the mixer will find its place in other foundries than those of large and heavy castings and of large tonnage. Wherever the quality of the castings to be obtained overshadows to a sufficient degree their price, the mixer can be built in very small units. In nearly every case where direct metal from the blast furnace is available the mixer can easily take the place of an air furnace.

The Pattern Shop Apprentice.*

By Jabez Nall.

While the past few years have witnessed some improvement in pattern shop machinery, and the introduction of some new labour-saving tools and devices, these merely aid, but in no sense make the pattern-maker's work automatic. His efficiency still depends upon his skill as an artisan and his ability to *think*. Notwithstanding specialisation of work, which is always found to some extent in large shops, it should be our aim, in the education of the pattern-shop apprentice, to produce a mechanic capable of doing any kind of pattern work. He should be able to adjust himself to the job in hand, and not to waste valuable time and energy producing a piano finish on something not worth while. Nor should he have an exaggerated idea of the importance of the microscopic dimensions required on a few patterns, which, if he attempts to attain on the vast bulk of the work, is wasted effort. However, he should be able to do this when necessary, and to split the hair-line when required.

Does the manufacturer take the best means to increase the efficiency and supply of good mechanics? It is an admitted fact that he feels the need of a better working force, and deplores the kind of help he is able to obtain. He complains of their inefficiency, as he would have a right to do, were it not for the fact that this condition is the result of an antiquated system of apprenticeship for which he is largely responsible. What opportunity is afforded the boy to learn his trade when placed in the shop without any preliminary knowledge of the requirements of the work he is given to perform? He thus becomes a part of the cheap help of the shop. If he is kept at this kind of work too long he becomes discouraged, loses all ambition, and early forms the habit of starting the day wishing for its close, and doing as little in the meantime as possible.

Under existing conditions the foreman is too busily engaged attending to the work going through the shop, and looking after the men, to devote any time to the special instruction of the apprentices, beyond such general information as he may be able to give the boys with reference to the job in hand when giving out the work, and a general supervision of the work as it progresses. To teach a boy how to grind, sharpen, and handle his tools so that he can successfully make a glued joint, turn a piece accurately in the lathe, or carve a block of wood to given lines does not make him a patternmaker. There is other information that he must acquire. In addition to such knowledge of mechanical drawing as he may be able to acquire in the course of his shop practice, he should be taught the principles of projection, such plane geometry at least as will enable him to construct his work with a saving of labour and material. He should also have some knowledge of mathematics, and the more of this the better. It is also essential that he have a knowledge of foundry methods and moulding practice. This of itself covers a wide range to-day. He should have other general information pertaining to the trade, such as a partial knowledge, at least, of modern machine shop practice, of the nature and properties of materials that are used, not only in the pattern, but in the finished casting. He should be taught his duties not only as a workman, but as a citizen. This would tend towards the making of the finished mechanic, the betterment of conditions in the shop, and an increase in the output.

To expect the small manufacturer to maintain an apprentice school, with a special instructor, is not justifiable, but he can contribute, with others, to the maintenance of such a school in his locality. I believe in the municipal control of these trade schools in preference to state control, and those who benefit most should defray the cost. One thing, at least, the manufacturer can do, even under present conditions, to improve the quality of mechanics, and that is to may the pay high enough to attract the bright, brainy boy to the trade.

The requirements of the trade are such that they demand, in the successful patternmaker, a high degree of intelligence and power of mental application. This being the case, one naturally seeks the boy whose training and record at school would indicate the possession of this knowledge. Suppose we take the boy who is a high-school graduate, or at least has had two or three years of high-school training. My experience, and that of others with whom I have talked on this subject, show him to be a failure. I am not willing to decry the advantages of education, but such boys have already been spoiled in the making. Consciously or unconsciously, the professors appear to have imbued him with the idea that he is not only different, but better, than the ordinary run of boys that have not had these advantages, and that he should not be asked to perform any menial duty. If, then, we reject the high-school boy who has mastered the classical course, how about the graduate of the technical school? This must depend upon the boy. If he only comes into the shop to take a post-graduate course, and is filled with the idea that all he needs is a few months' shop experience to fit him for an executive position, he is not wanted. It also would depend largely upon the nature of the course of study laid down by the school, and the amount of time given to the actual work, and whether the teacher was a practical man, with adequate shop experience himself. If we are to teach trades in school, let it be in the trades school proper, and let the teaching and development be such that a four years' course will place the students at least on an equality with the boy who has had four years of gruelling practice in the shop. For my own part, I prefer as an apprentice a healthy boy of good habits and a fair amount of animal spirit, who, having graduated from the grammar grades, and has had a year or two of shop discipline and experience, has reached the age of about seventeen, and has fully made up his mind that he wants to be a patternmaker, and the height of whose ambition is to be a good mechanic. With this kind of material to work with, I believe the best of results can be attained.

*Abstract of Paper read before the American Foundrymen's Association.

Briquetting Metal Borings.*

By Dr. Richard Moldenke.

One of the latest developments in the metal industry in connection with the utilisation of metallic waste is the process of briquetting it under enormous pressure, without the use of a binding medium. The process was originated by Arpad Ronay, of Buda-Pesth, who combined extreme pressure with a sufficiency of time to allow individual particles to get close together, excluding thereby spaces filled with air or water, which under pressure would tend to weaken the bond.

When the writer was first asked to investigate the process, before going to Europe to do so, he took one of the German briquettes made of cast borings, and melted it in his cupola, leaving the breast open so that by means of an iron bar contact could be had with the briquette from time to time, as it melted. It was found that the lump of briquetted borings melted just as a piece of pig-iron would, holding its shape until the final softening and dropping to the bottom.

and separated borings then pass into the feed hopper of the press.

The borings flow by gravity into the hopper of the press, then into the die, and as the plunger descends, receive their first compression. The air passes out as the borings go together, the separate particles curl into each other, and the partially completed briquette in the die passes on, carried by the revolving press table to the next stop, where plungers below and above apply pressure up to 35,000 lbs. per square inch. The die containing the briquette is free to move up or down at this point, giving the compressed material within freedom to adjust itself to an evenly distributed force.

On the withdrawal of the plungers, the revolving table makes another movement, placing the die with the finished briquette within (slightly conical in shape) under another plunger, which forces the briquette out and upon a band to take it away from the machine.

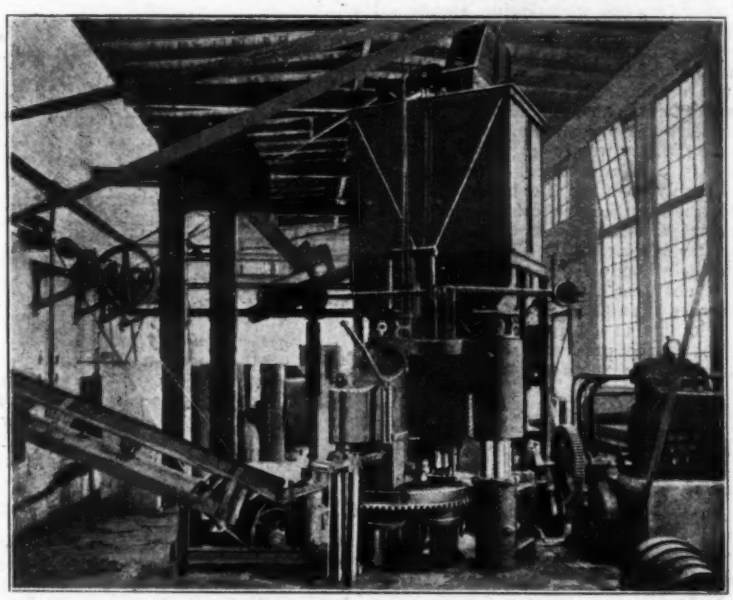


Fig. 1.—Large Press for Briquetting Borings.

The Method of Briquetting.

In general, the process may be described as follows: Cast iron, steel, brass, bronze, aluminium, copper chips, borings, filings and metallic slimes after drying, and for that matter sawdust, coal, graphite, salt, ore, flue dust, etc., go to a hopper above the press proper. In the case of borings, it is first necessary to allow these to pass by an exhaust fan, to remove dust and dirt (also taking the very fine graphite away). Incidentally, where there has been some slight rusting of the borings, the rubbing of the particles upon each other during transit loosens the rust, and this is drawn away by the exhaust, thereby greatly improving the quality of the briquette, as rust is never a good thing to go into the cupola. Steel turnings pass through a set of disintegrating rolls to reduce their bulk. After cleaning the borings by exhausting the dirt and sweepings, they pass over an electro-magnetic separator to remove brass from iron. The cleaned

All these movements are entirely automatic, the valve regulation being perfect, one man looking after the operation of the press itself, another taking the briquettes away, while a third sees that the hoppers are properly fed from borings received at the plant. A foreman machinist looks after the general operations, the pumps, accumulator and intensifying units.

It may be interesting to state that the briquettes, after leaving the press, become quite hot, so that any oil originally in the borings, and that applied to the die before filling either by a swab in the hands of the man at the press or automatically, does some smoking. Moisture present also disappears in a short while, the heat, however, not being sufficient to prevent the hand from resting on the briquettes for a moment.

One press with a capacity of 1½ tons an hour, and hence one of the small sizes, has been running regularly for several years, and, beyond the renewal of the cast iron dies every three months or so, has required no repairs. An intensifier is employed to

* From a Paper read before the Pittsburg Convention of the American Foundrymen's Association, May, 1911.

bring the water pressure of the very heavy pumps up to that of some 35,000 lbs. per square inch, as required for the work in hand. The larger cylinder of the intensifier is below the floor line. Two pumps develop the necessary primary pressures. An accumulator serves to insure even working and rapid action. Cast iron briquettes 6½ in. in diameter and 7 in. high, weighing 38 lbs. each, are formed.

Use of Borings in the Cupola.

The use of borings in the cupola is an affair probably as old as the cupola itself. Until quite recently, however, but little value has resulted in this direction. Whitney and Outerbridge were the first to give results to the public, and in the days of high-priced iron boxing up the borings in wooden containers answered fairly well. Then, again, in the anthracite region it was a common thing to use old powder cans, nearly filled up with borings, the tops beaten down and the cannisters charged into the cupola. Latterly an adaptation of this with the novel feature of continuous tubes filled with the borings has met with considerable success when carefully handled. All these methods, however, may be described as "fussy" even if effective, one works using all the old cans that could be obtained, until the supply gave out. With the briquetting method, however, which, aside from the royalty question, is the cheapest of them all, a new era was commenced, for the melting loss was reduced to a minimum, no apparatus was needed after the material left the press room, and the ordinary conduct of the foundry was in no way disturbed.

On the question of cupola practice, therefore, the use of briquettes simply parallels the use of pig-iron and heavy scrap, and inasmuch as the briquettes, in spite of the enormous pressure, are not fully as solid as pig-iron, they melt somewhat easier and faster than it, and from their handy shape and weight form an ideal cupola charging and melting material. Whereas borings when charged directly into the cupola lose anything up to 50 per cent. of their weight, besides ruining the product; when they are boxed, canned or melted in tubes the melting loss is not excessive, varying between 8 and 12 per cent., but the danger always remains that the cans or tubes will open and by discharging the loose borings over the coke bed ruin everything that follows until they are burned or melted and washed out.

In the case of briquettes, as in other melting tests made to get figures on a process, much depends upon how the melting is done. For instance, in melting ordinary pig-iron with small precautions to get the very best melting practice, the melting loss may amount to 3 per cent. and even over. Where, however, these precautions are taken repeated tests have made this loss about 1 per cent., and in the case of sandless pig as low as 0.3 per cent.—some carbon having probably been taken up during the melt. Hence also in the case of running complete heats of briquettes the melting loss with practice that gave 2.5 to 3 per cent. loss for all pig-iron gave 8 to 10 per cent. for the briquette loss. With careful practice, however, there is no difficulty in getting this down to 6 per cent.

As, however, no one would think of running a complete heat of briquettes for daily practice, but charge all the way from 10 to 80 per cent. of these articles, the rest being pig-iron and scrap, the melting loss of the heat will be about the normal one. In the case of a heat made with 80 per cent. briquettes and 20 per cent. pig-iron, the actual melting loss was only 3.5 per cent., showing either more careful practice or else that the comparatively heavy pig-iron held the temperatures in the cupola more sharply localised doing the melting where wanted without oxidising what was above.

There are some metallurgical changes in melting borings, whether loose or briquetted, which must be reckoned with. In melting a material which has such an enormous surface for a given weight, and which even when compressed practically solid to remove the disadvantages of the disproportion in question can still be permeated by gases to some extent when expanded by heat, certain changes will necessarily take place. The silicon will be lowered considerably more than is the case ordinarily; similarly the total carbon, while the sulphur taken up is about double the ordinary increase. This, of course, is particularly noticeable only when an entire heat of briquettes is to be reckoned with. Under ordinary conditions with part briquettes only, there is little difference noticeable, and for such work as cylinders of gas and steam engines, ammonia-plant castings and the like, there is a marked improvement on the part of the castings produced. This may be understood more readily by remembering the fact that a reduction in the total carbon and silicon corresponds to a steel addition to the charge. The slight increase in sulphur means a structure more finely granular, and hence a better wearing surface for cylinder work.

Inasmuch as the large locomotive works of the Continent are adopting the use of briquettes, and when proper melting practice prevails the castings made are perfectly sound and free from blow and pinholes, it is evident that the use of borings in the way described is not detrimental. In fact, strange as it may seem, in Germany these briquettes are actually sold at pig-iron prices, and at the Borsig works, for instance, the regular charges for steam and gas-engine cylinders, and other engine parts, refrigerating machinery (ammonia and sulphurous acid), hydraulic machinery and air compressors, superheated steam and steam-turbine apparatus, contain 40 per cent. of briquettes.

Perhaps one of the most interesting applications of the briquetting process lies in the ability to mix steel with cast borings. Here is an excellent way of charging steel into the cupola without burning up a portion of it before melting. The contact of a low-carbon with a high-carbon material means the melting down of this combination with an average carbon content. In the case of all-steel briquettes it may be said that for air or open-hearth furnace work these excel the regular heavy steel scrap in point of working. Not only do they melt faster, thereby shortening the heat considerably, but from the uniform size and shape they pile nicely in the furnace, allowing a better circulation of the gases to melt them than can ever be obtained by irregular and large scrap pieces.

As regards the briquetting of brass, bronze, aluminium, white metal and other metals, the melting losses are the same as the solid metal when melted, for in the case of all the softer metals and alloys, they are pressed together so closely that they are for all practical purposes sound pieces of metal. The finer the scrap the better the briquette, and hence a magnificent field has been opened for the economical recovery of the expensive metals in the foundry.

LIFTING MAGNETS.—At the Homestead Works of the Carnegie Steel Company it is claimed that two men, each operating a lifting magnet from the cage of a travelling crane, are now unloading an amount of scrap and pig-iron which formerly required 25 men. It is added that the two operators of the cranes and magnets are employed only part of the time on this work, while the 25 men displaced were employed all the time. At the dock of the Inland Steel Company at Indiana Harbour, Ind., U.S.A., in 10½ hours 2,000 tons of pig-iron were taken from the vessel by two cranes operating through lifting magnets.

Cupola Melting Practice.

By P. Munnoch.

In a Paper before the recent American Foundrymen's Convention, the author dealt with some points in British cupola practice. The following is an abstract of his remarks:—

Oxidation During Melting.

There are two effects which result from oxidation, one of which is the reduction in the amount of silicon and manganese during melting, and the other is the oxidation of the iron. More or less oxidation of iron always takes place, but the resulting metal is usually more or less free from oxide of iron and its effects. Often materials in the charge, as steel, oxidised scrap, or even pig-irons, receive the blame for causing the effects which are due to oxidation. In other cases or under other conditions, good clean metal, free from these defects, is obtained from the same materials. It, therefore, appears to depend largely upon conditions of melting. Dr. Moldenke has pointed out that the method of using large charges in the cupola is the chief cause of this trouble, and by reducing the size of the charges and therefore preventing any great variation in the height of the coke bed above the tuyeres, this oxidation is prevented. The term, large or small charge, is rather indefinite; therefore, it is desirable to have some standard for comparison. It might be defined in pounds of iron per square foot of cross-sectional area of the cupola, measured inside the lining. A charge of below 200 lbs. per square foot of cross-sectional area might be considered a small or suitable charge, and above this amount a large charge. As it is the coke which requires consideration there would still be some difference due to high or low melting ratios; also in the case of dense, heavy cokes as compared with light, porous coke. Therefore, the lower the melting ratio and the lower the density of the coke, the smaller the charge desirable. Therefore, in some cases, 100 lbs. per square foot sectional area might be ample.

The coke ratio in melting varies considerably, and results are often difficult to compare, as in some cases the coke used for the bed is included and in other cases left out of the calculation.

Total Coke Ratio.

This is obtained from total iron melted compared with total coke used; this is necessary when figuring costs. The coke melting ratio is obtained by comparing the average amount of iron per charge with the average amount of coke charged. This is most useful for comparing results under varying conditions, as it is not affected by the coke used for the bed. The coke melting ratio varies from about seven to one to fourteen to one, with ten to one as an average figure.

The rate of melting varies considerably, due partly to differences in tuyere area, blast pressure, also to the nature of the materials of the charge, whether dense or open, and also upon the coke melting ratio. A convenient method of comparing is to take the coke burned per unit of time, or iron melted per unit of time. In the blast furnace about 3½ lbs. of coke per square foot of hearth area per minute is considered an average figure, but only about 2½ lbs. of this reaches the hearth and is burnt by the blast. For cupolas about 2½ lbs. per minute per square foot of cross-sectional area is a good rate of working, results being often considerably less. The area of cross section multiplied by 2½ and the result multiplied by 60 (minutes) gives the ideal coke consumption per hour. This multiplied by 10 gives the ideal rate of melting in pounds of iron per hour, or multiplied by the actual coke melting ratio, gives the rate of melting which might be expected under good conditions. These figures are useful to compare with the actual melting rate.

Diameter inside lining. ft. ins.	Area in sq. ft.	Coke.		Iron. Melted at 10 to 1 ratio.		Charge of iron at 200 lbs. per sq. ft. area.
		At 2 lbs. per sq. ft. per minute.	150 lbs. per sq. ft. per hour.	Lbs. per hour.	Tons per hour.	
2—0	3.14	7.85	471	4,710	2.10	628
2—6	4.90	12.25	735	7,350	3.28	980
3—0	7.07	17.67	1.060	10,600	4.73	1,414
3—6	9.62	24.05	1.443	14,430	6.44	1,924
4—0	12.56	3 .30	1.878	18,780	8.38	2,512
4—6	15 90	39.75	2.38.	23,850	10.64	3,189
5—0	19.63	49.07	2 944	29,440	13.14	3,926
5—6	23.75	59.37	3.562	35,620	15.90	4,750
6—0	28.27	70 67	4.240	42,400	18.92	5,6 4
6—6	33.18	82.95	4.977	49,770	22.21	6,636
7—0	38.48	96 20	5 772	57,720	25.76	7,690
7—6	44.17	110.42	6.625	66,250	29 57	8,834
8—0	50,26	125.65	7.539	75,390	33.65	10,052

Changes Occurring During Melting.

Some of these are of a more or less stereotyped kind, such as the decrease by about 0.25 per cent. of silicon and reduction of manganese by about one-fourth of the amount present, whether this is 2.0 per cent. or only 0.2 per cent. Whilst these apply in a general way, still, in particular instances, we find that conditions have considerable influence; this is especially noticeable with sulphur. When melting all-pig charges containing 1.2 to 1.4 per cent. of manganese a decrease in the amount of sulphur of about 0.02 to 0.04 per cent. was usually noted. Melting pig and scrap mixtures containing about the same amount of manganese usually resulted in an increase of 0.02 to 0.04 per cent. of sulphur. The scrap consisted of gates and runners from small castings and constituted about 50 per cent. of the charge.

Borings, when added loose or in wooden boxes, usually result in increased absorption of sulphur. In some experiments using about 14 per cent. of loose borings in the charge, the increase in sulphur was about 0.06 per cent., although about 1 per cent. of manganese was present. An experiment was tried melting borings alone by charging small amounts to the cupola after blowing down; the resulting metal contained about 0.3 per cent. of sulphur although the borings only contained 0.06 per cent. In melting good, clean steel scrap with iron, the amount of sulphur taken up was much the same as when the charge was all cast iron. The amount of sulphur in the coke has a great influence on the resulting sulphur content of the melted iron.

Although limestone is the usual flux for the cupola, other materials are sometimes used. A founder complained to the blast-furnace people who supplied him with pig-iron that the iron was giving bad results. On investigation, it was found that he was using blast-furnace slag as a flux instead of limestone. The

slag contained about 2 per cent. of sulphur. As the castings made from the iron were small, there was sufficient sulphur taken up to change the castings from grey to white. Low-sulphur materials are a necessity when low sulphur castings are required, but there are cases where some increase in sulphur is not objectionable and then a higher content of sulphur may be permitted in metal or coke.

When iron is melted in the cupola without the addition of a flux, the slags formed are chiefly silicates of iron, manganese and alumina. On addition of lime, silicate of lime is formed, and the slag becomes more refractory as the lime increases, due to some extent to the lime replacing the more fusible iron and manganese oxides. The object of adding lime may be either to flux away the excess of silicious matter, such as coke ash, sand from iron, and particles of silicious matter from the lining, so as to prevent the accumulation which would interfere with the regular melting of the iron, or to do this and also to purify the iron and prevent absorption of injurious constituents. The usual loss of silicon and manganese cannot be classed as purification, as the reduction in amount is not always desired or necessary. Removal of sulphur may, in most cases, be called purification, but in other cases it may be necessary to retain or even increase the sulphur. Removal of oxides and prevention of increase of oxides are the only actions which are always desired.

Removal of the Sulphur.

Using coke containing about 1 per cent. of sulphur and melting with a ratio of 10 to 1, there is sufficient sulphur present to increase the sulphur content of the iron by 0.10 per cent., or to raise the sulphur content of the slag to 1.5 or 2.0 per cent. Ordinary cupola slag, however, seldom contains more than 0.10 or 0.20 per cent. of sulphur. This is due to the slags being silicious or acid in character. Large additions of lime would make the slag capable of taking up more sulphur, but the slags would rapidly attack the silicious lining and would be too refractory for ordinary cupola operations. Increase of lime, to some extent, prevents increase of sulphur in the iron, and this must be due to the higher temperature necessary to melt the slag being more favourable to removal of sulphur by oxidation. Manganese in the iron or manganese oxide in the slag probably remove sulphur into the slag as manganese sulphide, and sulphur is then oxidised to sulphur dioxide, which escapes in the form of gas.

Action of Slags in Regard to Oxide in Metal.

In the cupola the composition of the slag does not appear to have much effect, but it is reasonable to suppose that iron melted and held in contact with slags rich in oxide of iron will become oxidised to some extent. As the use of lime decreases the amount of oxide of iron in the slag, this must be more favourable to the production of metal free from oxides. In such a case the slag itself will, under suitable conditions, remove oxide to some extent from oxidised iron. The use of limestone is, therefore, advantageous in cupola melting.

Slags are usually controlled by following certain types of slag with a more or less flexible ratio of acid to base, or more generally, silica to lime or to lime and magnesia. In the cupola, slags seldom contain more than one part of lime to two parts of silica. This may, therefore, be adopted as a suitable basis for calculation. Using coke with about 10 per cent. of ash, one-half of which is silica, and a melting ratio of ten to one, gives about 10 lbs. of silica per 2,000 lbs. of iron. Sand-cast pig may carry from 5 to 30 lbs. of sand per 2,000 lbs. of pig, according to time in stock and amount of handling it has received.

Shop scrap, such as gates, runners, etc., may carry a great deal of sand, probably from 30 to 60 lbs. or more per 2,000 lbs. Sand may be taken to be all silica for purpose of calculation. Silica from the silicon oxidised from 2,000 lbs. of iron is about 10 lbs. Silica from the furnace lining is variable and difficult to estimate, as it varies according to temperature and composition of the slag. A rough idea may be obtained from the amount of ganister used. As all figures are based on mere estimates, a rough calculation is all that is necessary. A few experiments using a pickling solution, or otherwise removing sand, would be useful for this purpose. Limestone will probably contain about 50 per cent., or slightly above, of available lime. Therefore, equal weights of limestone to silica in the components of the charge used will give the suitable amount to add, after making allowance for silica from the lining. Generally the amount required will vary between 30 and 60 lbs. per 2,000 lbs. of iron.

Milling Machine Cutters.

Discussing this subject before the Canadian Railway Club, Mr. W. M. Townsend said that these tools are generally made from carbon tool steel, but that far more efficient and satisfactory cutters in small sizes can be made from high-carbon mild steel, such as is frequently used for driving shafts, piston rods, etc., and containing 0.45 per cent. of carbon, about the same percentage of manganese, not more than 0.05 per cent. of sulphur and 0.05 per cent. of phosphorus. This material must be well hammered to size, and then machined and the teeth cut. Most important, of course, is the hardening, which consists of packing the cutters in a mixture of salt and raw bone, placing in an air-tight box, which should be kept at a heat of 1,500 deg. F. for from 24 to 48 hours according to size, then drawing the cutters from the box and immersing them in running water. No further tempering operations are necessary, and, contends the author, cutters made and treated by this method completely outclass in every way the ordinary milling cutters, as the teeth will not break when a heavy cut is put on, and the body of the cutter is extremely tough. The hardening penetrates up to a depth of $\frac{3}{8}$ in., and lasts until the tooth is practically ground away. This method applies to cutters for plain milling, and not for gear and reamer cutters.

Metallic Titanium.

Recent attempts to prepare pure titanium showed that the reduction of sodium titanifluoride by potassium yielded material containing 73.2 per cent. of titanium. A still poorer result was obtained with potassium and barium titanifluoride. The reductions of titanium dioxide by carbon yielded a product never containing less than 4.6 per cent. of carbon. It is doubtful whether metallic titanium can be thus prepared; the product contains varying quantities of titanium carbide and monoxide. Nilson and Petersson produced titanium of 95 per cent. by reducing titanium tetrachloride with sodium. Pure titanium has been obtained by this method, taking extreme care to exclude air from the apparatus—a steel bomb with a clamped-down lid. The reaction is also instantaneous when the bomb is heated to dull redness. The product gave 99.9 and 100.2 per cent. of titanium. The metal resembles polished steel. It is hard and brittle when cold, but can be easily forged at red heat. The melting point is between 1,800 degrees C. and 1,850 degrees C. Its specified gravity is 4.50.

Steel Foundry Practice.

In a recent issue of "The Iron Age," Mr. E. Herms gives the following interesting notes based on his experience in steel foundry practice in the St. Louis and Pittsburg districts:—

Acid and Basic Steels.

Acid steel is not as desirable as basic steel where shrinkage is an important factor in causing cracks, as in the casting of bolsters for cars, charging-machine boxes, cast-steel ladles, annealing boxes, and the like; for the general run of acid steel is more liable to crack than a low-phosphorus basic steel. The reason for this is not so clear, as the slightly larger percentage of sulphur in acid steel—which sulphur content tends to red shortness—can hardly account for this tendency to crack; for in reality in basic castings it is found that cracks are related to the phosphorus content, and that castings that will crack with 0.040 phosphorus will cease to crack or show much smaller cracks at 0.015 phosphorus content, without any variation in the sulphur content. These cracks are not cold cracks, but hot cracks. It is always aimed to get the phosphorus content low in plants that make a speciality of railroad castings, in order to avoid the cracks. Two foundries in the St. Louis district tried acid steel for making bolsters, but were compelled to give up the practice. The fact that acid steel is more prone to crack may be due to its greater density and consequent greater shrinkage.

To make low-phosphorus basic steel it is necessary to have as little silica as possible in the charge. The pig-iron must be low in silicon—the lower the better, and 1 per cent. is the limit generally allowed; the scrap should be low in silicon; also the limestone should be low in silica—better under 1 per cent. Magnesia does not make a good slag, and should be low in the limestone. Of course, the phosphorus and sulphur should be low. The more impure the limestone the more will be needed, and the excess is only a barrier to the working of the heat, as it is a poor conductor, preventing the heat from entering; and endangering the furnace. As much as 18 per cent. limestone to the charge is used where the charge runs high in phosphorus, as with Southern (U.S.A.) pig, which runs close to 1 per cent., and in this case it is not uncommon to get under 0.010 phosphorus in the finished steel. With 0.40 per cent. phosphorus in the pig-iron, 14 to 15 per cent. of limestone to the charge is sufficient. It is customary to make a preliminary phosphorus examination before tapping a basic heat, and if the phosphorus is found too high, it is reduced by adding unslacked lime in small lumps after the bath is first given some action by adding pig-iron or fluorspar. It is found that iron ore, pig-iron, and fluorspar added together to a very low carbon will reduce the phosphorus. By working the heat with an oxidising flame the phosphorus is readily removed and often absent when the heat is thoroughly melted.

Additions to the Bath.

The limestone is charged on the bottom, or the bottom is first covered with scrap to prevent the limestone from adhering. When the charge is melted there will be a violent boiling on the bottom until all the lime is up and floating on the charge in large chunks. The heat is then worked by giving it lumps of iron ore in suitable quantities so as not to cause foaming or unnecessary cooling of the heat by large disengagement of gases. The chunks of lime floating on the surface, under this influence, are gradually converted into slag. Fluorspar will hasten this process of dissolving the lime, but it must not be added until the carbon in the bath is under 0.40, for otherwise the bath will foam and delay the heat. This foaming of the heat has some relation to the iron ore used, for it appears that with a high carbon the iron ore does not reduce the carbon as rapidly as with a lower carbon, and thus that the gases generated must be held in solution. True it is that the activity of the bath is greater the lower the carbon, until a lower limit is reached. This gas the fluorspar seems to loose, which, with the slag, causes foaming. With a foaming heat there is nothing to do but to wait until the foam subsides. Fluorspar can be added slowly to a high-carbon bath to which no ore has been added, which is the practice in making high-carbon basic heats. Pig-iron also causes foaming when added to a high-carbon basic heat to which ore has been added. Any cold metal added to the bath at any time causes disengagement of gas, but not always any considerable foaming. Thus it is a good practice to add cold metal, as pig-iron, at the close of the heat to disengage the gas and thus help kill the bath, making more solid castings. Ferro-silicon, 10 to 12 per cent., is also good for this purpose, and it is a common practice to add 500 lbs. to 800 lbs. to a bath of 20 tons just before tapping. Much more can be used with good effect in making high-carbon basic steel come solid, and it is well to preheat the ferro-silicon in a little furnace for that purpose. In this way 1,500 lbs. to 1,800 lbs. can be used in a 20-ton bath in making high-carbon rolls, and will give solid castings. The increase in phosphorus from the ferro-silicon, when using good materials, is insignificant.

In making nickel-steel castings it is well to add the nickel to the bath when the carbon is low, a little before the final additions of manganese and silicon. If nickel scrap steel is used it is well to make a preliminary nickel test just before tapping, so that the final nickel content can be safely assured. There is no loss of nickel to the slag, and an acid or basic hearth is equally applicable.

Care must be taken in making additions to the ladle that they are all dissolved before the slag enters the ladle, for if added too late the last few castings may be very high in silicon or manganese, or both, causing the castings to be brittle. The last 1,000 lbs. of steel from the ladle of a basic heat is rather inferior, being high in phosphorus. The basic ladle should not contain too much slag over the metal, as this hot slag is apt to cut the sleeves off the stopper rod if the heat is long in pouring. This can be partly adjusted by adding or removing brick from the ladle lip spout. The nozzle should be well preheated to prevent the sticking of the stopper.

To Prevent Piping and Shrink Holes.

A good plan to prevent piping and shrink holes is to cover the heads just as soon as filled, with blacklead or plumbago. This will prevent a crust from forming and keep the metal liquid, so that it will sink down to feed any shrinkage of the castings. Charcoal will also keep a head open if stirred with an iron rod; but anthracite will not do, as it is absorbed more freely and is apt to raise the carbon so as to make it difficult to cut off the heads unless this is done with an oxygen blast. In making rolls of acid and basic steel it is found that acid steel gives the largest "pipe."

With care basic high-carbon castings, including rolls, can be made to come solid up to 1.10 and 1.25 carbon.

The analysis of castings varies somewhat with their purpose. Where high physical properties are required and the steel must withstand shock to a high degree, the carbon and phosphorus must be low. For bolsters 0.18 to 0.23 carbon is good with phosphorus as low as possible, preferably under 0.025. The manganese is desired above 0.70 and under 0.85, although 0.90 is not bad with a low carbon. Silicon ranges from 0.25 to 0.35, and even 0.40. When castings must be machined, soft steel includes anything, roughly speaking, up to 0.30 carbon, and it is well to have the manganese and silicon well up to ensure solidity. A little aluminium added to the metal as it enters the pouring basin will help to ensure solidity.

Moulding Conditions.

The condition of the liquid steel is not alone responsible for solid castings, for the condition of the mould is equally important. There must be plenty of vent in the mould, for if the vent is poor the steel will contain blowholes. Efficient venting is interrupted by a dense mould or dampness. Dampness seems to be the worst enemy. Acid steel will not come solid in green sand much more than basic steel, yet by adding sufficient aluminium to the metal as it enters a well-vented mould a degree of solidity can be attained that is satisfactory for a good deal of work. Dampness seems to be the principal cause of the facing burning into the mould or the steel hardness of certain cores, which makes it all but impossible to remove them. Yet an excess of fireclay will cause this trouble as well as a low class of core materials. Scabbing is often caused by dampness. All cracks are not due to the condition of the metal, but the manner of gating, the design of the pattern, and the hardness of the facing are important. By distributing the flow of metal into the mould more uniformly, thus preventing a hot streak or line of weakness, while most of the metal has chilled, will often obviate a crack.

The sand for moulding should be silica sand of high silica content, the higher the better. Sharp sand is not so desirable for green-sand work. The silica should run above 97 per cent. Various degrees of fineness have been used with success, although it is understood the sand should be rather coarse. The fireclay to mix with this sand should be refractory and of high tensile strength, especially in green-sand work. There are three kinds of bond in fireclay: the stickiness in the wet condition, that of the air-dried condition, and finally that developed by firing. The first kind is essential to green-sand work, the first two are right for dry-sand work. If a natural sand of sufficient tensile strength could be found of a coarse texture and about 3 to 4 per cent. alumina and 93 per cent. silica, with 3 per cent. combined water and little other impurities, we would have an ideal moulding sand. If the alumina runs high in the sand the silica and alumina will flux from the high heat of the steel and burn into the surface of the casting. A dry-sand moulding mixture requires less clay than green-sand, for here the molasses water or glutrin furnishes the bond by drying and baking. There is much foundry flour on the market that contains large quantities of carbonate or sulphate of lime, even up to 50 per cent. of the impurity, and this is objectionable as a steel foundry material because of its fluxing and fusible properties. The sand mixtures are preferably mixed dry, as only thus will the clay penetrate the mass the more thoroughly. Steel castings can be made to peel clean, so that very little grinding and chipping are necessary, and this is attainable when good facing is used.

Foundry Buildings.

Writing on the subject of foundry construction, Mr. G. K. Hooper (American Foundrymen's Association) said:—

Thorough preliminary work also tends to cheapen the cost of the building structure, as, after the apparatus has been located, short roof spans may be adopted in certain cases, when building columns can be placed so as not to interfere with the equipment or operations. Conversely, large spans and heavy trusses may be used to avoid placing building columns in such positions as might increase the cost of the equipment and interfere with production. Although at times this adds materially to the cost of the building structure, it is chargeable only to the amortisation account, while a row of columns which interfere with the handling of materials, or which sever the continuity of the routing of the product, would set up and maintain a perpetual charge against the cost of production.

Portions of the building over some types of apparatus, such as conveyors and high-bucket elevators, for instance, can be specially treated, leaving the rest of the building more or less standard, whereas if the designing of the building is allowed to proceed regardless of special equipment problems, a large part of the building may have to be treated expensively, so as not to interfere with the special apparatus when these are finally decided on.

The building structure may be treated as an independent unit in the general scheme, after the modifying elements in the preliminary layout have been considered and decided, and their bearing on the building determined.

In place of the single-storied building, with crane or cranes carried on columns or on side walls, with a light steel or wooden truss sufficient only to carry a roof of comparatively light construction, we have a building of heavy and modern steel design capable of sustaining machinery loads of considerable weight, and of absorbing the vibratory stresses and shocks imposed by this equipment.

Preferably, the structure takes the form of a steel skeleton with certain walls and masonry pilasters, concrete floors, metal sash windows, in some cases, heavy steel trusses supporting a roof of one of the acceptable forms of concrete tile now available.

For finishing and dispatching departments on the ground floor of foundry buildings a tar concrete base, carrying a Georgia pine rough floor with a finish floor of factory maple or beech, has given good satisfaction, while concrete floors present a good working surface for most operations which is beyond criticism. In some cases, however, it becomes necessary to select special flooring to meet severe conditions. For malleable foundries using mechanical charging trucks operated either by steam or compressed air, a flooring material embodying a wearing surface sufficiently tough to withstand the tractive effect of the driving wheels, as well as the necessary strength to carry the heavy loads transported by these machines, is required.

The hardest surface succumbs rapidly to the slip of the driving wheels, and where steel plates have been used to protect the finished surface of the concrete they have been found to buckle badly. Wooden paving blocks seem to offer so far the only solution, and these make a very satisfactory flooring for this service. The expensive creosoted block, such as is used for street pavings, is not required in foundry work, however, as a much cheaper type of block can be used which gives equally as good results.

Unconsidered Trifles Connected with Foundry Work.

By J. Horner.

Foremen are often hauled over the coals about trifles which one seldom or never sees any notice taken of by writers. They are those little matters which, but for the fact that they throw extra work on other departments, would not be criticised.

Seldom does a day pass in the life of a foreman patternmaker in which he is not called into the machine shop and turnery to explain why such and such things could not have been avoided. And some of these appear so trifling in themselves, such as a bit of hard fin, a long core pushed slightly out of place, or perhaps bent a trifle, a difference in dimensions due to taper on a deep lift, too much or too little shrinkage or too much or too little allowance for tooling; and when, in order to correct these objectionable features, alterations are made in standardised patterns, the uncertainties attendant on moulding and casting result in other inaccuracies, so that another alteration perhaps follows, and things may have to be put back as they were originally.

Great objections are made in the machine shop and turnery against having too little or too much to tool off. When castings will not "hold up" properly to dimensions all over they must in many cases be scrapped; in others some of the "black" must be left in, which has a bad appearance. If the allowance comes out excessive in amount, an extra cut often has to be taken, but the latter is less objectionable now than it was a few years since, because modern machines are better designed to stand up to heavy tooling.

Yet it is not easy to ensure a moderate and uniform amount for machining in the case of the larger castings. It is simple enough in small work, but not in large and intricate pieces. Apart from the differences due to rapping and delivery, there are others which arise from straining of the moulds, from differences in the degrees of ramming done, those due to the presence of hard cores, to the variations in the quality of metal mixed from day to day, and in the temperature at which pouring is done, and the results of these increase with the mass of the castings. In loam work especially, and in work containing a large number of cores, the differences are more marked than in plain castings made in green sand. The bricks in loam moulds, and the presence of hard, dried cores delay shrinkage considerably unless they can be partly or wholly loosened, or broken up, before the casting has done its shrinking. Because of these things there is almost invariably a difference in the diameters at top and bottom of large cylinders, cast upright, and they explain many apparent discrepancies in the sizes of patterns and core boxes, and their castings. A cylinder which the writer remembers had ports about three feet in length in which the ribs which should have tied the port walls together were omitted, and there was in consequence a difference of over ¼ inch in the width of the ports at the middle and ends, being wider at the middle due to the resistance of the core to shrinkage. Frequently in work which consists largely of cores, no shrinkage, or scarcely any, takes place. Yet the patternmaker can hardly allow for this because the moulder may break up the cores at one time, and leave them in at another, with resulting differences in shrinkage. Sometimes in flimsy castings the leaving in of a core will cause the casting to fracture, due to its shrinkage being prevented by the presence of the hard core.

Another and very important point is the differences in allowances which are made in top and bottom of the mould and in the ways of moulding a given face, whether up or down. It is an unwritten rule that whenever practicable the face which has to be soundest and cleanest must not be cast in the top, but downwards. But numerous cases occur in which both top and bottom are required equally sound, and then various devices are adopted to ensure a clean top. One is to leave extra allowance there for tooling. Another is to pour through a skimming chamber. Another, to cast several risers over the face, or else a large head of metal. Another is to melt the metal very hot and thoroughly. Or all are used in combination. It therefore often happens that a considerably larger amount has to be planed or turned off a top face than off the bottom, the necessity for which the machinist may not recognise, but which the moulder does.

Allied to this subject is the inaccuracy frequently due to the incorrect setting of drawbacks and of cores. Though the first are rammed in place, and the second set by print impressions, they do not always fit quite correctly, or, if they do, they may become shifted by the pressure of the metal. These are very common sources of error in castings, the reason for which does not appear in the patterns at all. Mischief is frequently caused at the final closing of the mould, due to the pushing of cores or drawbacks out of place, and the crushing of sand, so distorting the forms of the castings. It is necessary, first, to thoroughly secure every drawback and every core from the risk of movement, whether caused by the closing of the mould or by the liquid pressure due to pouring; and to lift the cope off once at least after the mould is closed as ready for pouring, to be sure that nothing has been disturbed by the closing.

A small matter, apparently, is the jointing of patterns and moulds. Yet these give trouble in many ways in the machine and fitting shop. They often involve tooling a face that might but for the jointing have been left rough. Sometimes they render necessary the taking of two cuts where otherwise one would have been sufficient. Wherever a mould is jointed, the sides slope away in some degree from the plane of the joint, and in many cases there is also a fin and an overlap, due to the improper closing and setting of the moulding boxes. Sometimes this is aggravated by the mending up of the edges of broken moulds, which is seldom done correctly unless the pattern is returned into place, which in heavy work is not practicable. Thick fins often occur in dried-sand moulds, due to the pressing down of the joint faces while green with the trowel, to prevent risk of crushing, and also in loam moulds, due to the striking up of the mould parts separately.

The starting and overlapping of glued pattern joints often leaves marks in the mould. Sometimes castings show the construction of the pattern exactly, even to the very grain of the wood. The pattern joints may show exactly as they occur, or they may by their overlap drag up the sand and leave marks on it from bottom to top, depending on their position. Here one incidental advantage of metal patterns comes in, for however well wooden patterns are constructed they must inevitably become distorted unless subject to constant attention and repairs.

C

Cupola Linings, Fluxes and Slag.

By M. Albuetz.

The frequent complaints about the rapid destruction and melting away of linings in cupolas gives sufficient inducement to discuss more extensively this subject from both the economical and practical points of view. It must, however, be pointed out that the question of actual cupola practice will be dealt with in future articles, and any reference made to cupolas in this article will only be more or less general. Fluxes and slag, however, stand in direct relation to the lining of the cupola from the metallurgical point of view, and could not be discussed, therefore, without any reference to the lining, and in order to make the question of fluxes and slags in the process of grey-iron melting in the cupola as comprehensive as possible, the following four points will have to be considered:—

(1). Construction and material of cupola lining.
(2). The nature of fluxes and slag.
(3). Formation of slag.
(4). The effect of fluxes on castings.

Lining of Cupolas.

The rapid destruction of the lining is caused through mechanical, physical and chemical actions and reactions, and in order to realise more fully that these various actions and processes increase and decrease in severity at various points in the cupola, it is proposed to divide the cupola, as far as the lining is concerned, into four different sections or zones (see Fig. 1); and it is further suggested that the cupola charge be followed from where it is charged down to the point where the molten metal leaves the cupola.

Beginning with the third section or zone from the charging floor downwards; here in this part the destruction of the lining is mostly brought about through mechanical action, as the temperature of the gases at this point of the cupola has fallen to such a degree that it has no longer any material effect on the lining. It is, however, the charging of the raw material, especially the iron charges, which are most likely to damage the lining at this portion of the cupola, and however carefully the charging may be done, unless a specially constructed lining is provided, re-lining will be necessary at short intervals. To overcome the continual breaking away of the brickwork, the cheapest and most efficient method is to fix from the level of the charging floor downwards a cast-iron or preferably a cast-steel ring, from about 12 in. to 16 in. deep, with a thickness all round of 1 in. to 1½ in., according to the size of the furnace and the nature of the material to be charged therein. This ring can also be made in sections provided with flanges, the latter being bolted to the shell of the cupola. If made in sections the depth may be increased to 20 in., and this depth will at least protect those parts of the furnace wall where it would otherwise suffer from the impact of heavy pieces of pig-iron. Below the cast-iron or cast-steel ring mentioned there is further the friction of the descending charges along the lining, and in conjunction with the increasing temperature the wear and tear will now become quite considerable, and therefore only the best of materials should be used, to withstand rather the mechanical action than either high temperature or chemical actions.

Second Zone.—The lining begins to suffer here less through mechanical action such as impact, but there is still a certain amount of friction down along the lining. On the other hand, however, the temperature is becoming gradually higher (2,000 deg. to 2,200 deg. Fahr.). Chemical action and reaction and, therefore, the formation of slag, begin to take place, and the charge has at this stage entered what is called the "melting zone."

First Zone.—This includes the part of the cupola from the tuyeres downwards to the bottom, and is chiefly occupied by the accumulating metal, the coke bed and slag. The lining here is similarly influenced as in the case of the melting zone above. It will be seen therefore that the two lowermost zones demand equally good material, namely, to be refractory and possess a certain amount of resistance against chemical reaction.

Fourth Zone.—This includes that part of the cupola above the charging door, and may end in the form of either a spark arrester or an ordinary straight chimney shaft. No mechanical actions take place here on the lining, and the temperature in a well-managed cupola should not be higher than from 300 deg. to 400 deg. Fahr., and therefore more or less inferior material can be used, although it is supposed that the lining here should last the full lifetime of the cupola itself.

Construction of Lining.

This can be done in two ways, either by ramming up the required thickness of lining in the form of a solid mass, or building up by means of special shaped stones, commonly called cupola bricks. The latter method has the advantage of being built up with greater ease and accuracy, whilst the former method is considerably cheaper. Apart from the quality of material of the lining, the first question will be whether the lining should be of acid or basic material, but this will be dealt with more extensively under the heading of "Slag," but invariably a basic lining will give better results in melting and have a longer life. Wherever possible, the use of shaped bricks should be given preference, not only because same can be placed into the different zones according to their respective quality, but the physical and chemical resistance is a much higher one than in the case of an ordinary rammed up lining. Besides, the structure of the bricks is more uniform and closer, and must naturally possess greater resistance against wear and tear and high temperature alike. The material used for rammed-up linings is of a plastic nature (generally ganister with a sufficient percentage of clay to give the required bond) containing a considerable quantity of moisture, and unless the greatest care is taken in drying the lining uniformly throughout, cracks may occur in some places on account of rapid overheating, whilst along the shell or casing of the cupola the lining may still contain a certain amount of moisture and steam, thus leading if not to explosion at least to abnormal destruction of the lining at an early stage.

If the lining is built up with cupola bricks the mortar or grout used in connection therewith should when being prepared be tempered with hot water and applied in a warm condition. This material should likewise be of a refractory nature, such as ganister, a material containing about 75 per cent. to 80 per cent. of silica or quartz, together with about 25 per cent. to 20 per cent. of basic and neutral substances, chiefly alumina. The percentage of the basic substances should be kept as low as possible, and is only required to give the quartz the necessary bond and plasticity. The parting of two adjoining bricks should be about ⅛ inch and the grout or mortar should be in a sufficiently thin condition to fill out the joints properly. The high temperature to which the lining is exposed

will bring the basic substances to a combination with the ganister or quartz, forming a silicate of alumina. This combination between the firebricks and the mortar is especially advantageous, inasmuch as a kind of glazed surface is obtained, joining or welding the lining into a highly refractory and solid mass. Refractory or fireproof cement has occasionally been tried without success, because the above-mentioned process of joining the firebricks and the grout together to a glazed mass is, on account of the chemical composition of cement, not possible. The quality of the mortar or grout should, of course, be selected and used according to the respective position on the lining, namely, the best material where the highest temperature exists.

The fourth zone, or the portion above the charging floor, and which may end, as mentioned before, in the form of a spark-arrester or straight chimney shaft, does not require to be lined with ganister, but a good quality of fireproof builders' brick will be quite sufficient, as the temperature should not exceed 400 deg. Fahr. It is, however, strongly advisable to use ganister mortar for filling in the joints between the bricks, because ordinary lime or cement mortar will very often cause cracks and subsequent early destruction of the lining.

Thickness of Lining.—The thickness of the lining may vary from 5 in. to 9 in. in smaller cupolas and comparatively short heats, whilst in larger cupolas and such for continuous melting the thickness may be from 8 in. to 12 in. A thickness of more than 12 in. should only be used with cupolas melting from 15 tons per hour and more, or for a prolonged heat from 24 to 48 hours, and should in no case exceed 15 in., because one must not lose sight of the fact that the absorption of heat through unnecessarily increased thickness of lining will become quite an important factor, and especially so where the heat extends over only say two to three hours, as will be seen from the following example.

Heat Lost through Absorption of Lining.—Suppose the lining which has an increased thickness of 15 in. from the bottom of the cupola and extending with the same thickness to a height of 8 ft., which is equal to about the height of the melting zone, a shell diameter of 72 in., internal lining of 42 in., and an average temperature $= \frac{3{,}000\ 300}{2} = 1{,}600°$. The amount of heat absorbed in this portion of the lining would be:—

$$\frac{D^2\pi}{4} - \frac{d^2\pi}{4} \times h \times Sg \times Sh \times T = B.Th.U.$$

D = Diameter of casing ... ... = 72 in.
d = Diameter of lining, internal ... = 42 in.
h = Height of lining up to top of melting zone = 96 in.
Sg = Specific gravity of lining ... ... = 2.2
Sh = Specific heat of lining ... ... = 0.2
T = Average temperature of lining = 1,600 deg. Fahr.

$$\frac{72^2\pi}{4} - \frac{42^2\pi}{4} \times 96 \times 2.2 \times 0.2 \times 1{,}600 = 6{,}400{,}000\ B.Th.U$$

Taking the amount of heat of average coke at 13,500 B.Th.U., we have: $\frac{6{,}400{,}000}{13{,}500} = 475$ lb. coke.

The heat absorbed through the lining = 475 lbs. coke per heat.

There are, however, cases where such abnormal thicknesses of lining are found, especially in cupolas which have been installed with a view to increasing the melting capacity, according to the continual expansion of the concern in question, and consequently a larger output of finished castings. That is to say, the melting capacity can more or less be regulated by the thickness of lining and subsequent internal diameter, by using the same cupola. For instance, a cupola having a diameter of casing of 72 in. can when installed be lined to give an internal diameter of 42 in. or a thickness of 15 in., and this may give an average melting capacity of say seven tons per hour. If, however, circumstances demand it, the same cupola, but with a reduced thickness of lining down to 9 in., which then equals an internal diameter of 54 in., could melt on an average about nine tons per hour. As already mentioned, however, the loss of heat, and higher initial cost of a larger cupola than actually required, remains to be decided in every individual instance. Taking the same cupola, but having only a thickness of lining of 6 in. instead of 15 in., then the heat absorbed would be:—

$\frac{4{,}400{,}000}{13{,}500} = 320$ lb. of coke, showing a saving of 155 lbs.

The 15 in. lining will, therefore, absorb every heat nearly 1½ cwts. of coke more than the 6-in. lining. However carefully the lining of a cupola is built up, even with the best of material, destruction and continual melting away of the brickwork will occur, especially in the two lower zones, and after each heat the shape and internal dimensions will vary, and this will very often influence the melting process.

Daubing or Repairing.

These operations serve two special purposes, the first being to keep the internal dimensions as uniform and constant as possible, and the second to protect the actual brickwork from too high a temperature. After dumping the cupola and allowing it sufficient time to cool down, all projecting portions of slag and cinder are chipped away and the lining trimmed up to its proper shape. In doing this it is not necessary to cut away forcibly all the adherent masses right down to the brick lining, because very often the hard glazed cinder is more refractory than the new ganister put on the top, and, furthermore, if the lining is chipped and knocked too forcibly the actual brickwork will become loose. Daubing, or the thickness of the new ganister put on the lining, should not exceed 1 in. or 1½ in. except where small holes have to be filled up, and this should be done wherever possible with smaller pieces of cupola bricks. The clay in the ganister contains water chemically bound, and if put in layers exceeding 1½ in. it is impossible to expel the water within a comparatively short time, and if too high a heat is applied during the drying the lining will only become glazed on the outside whilst the water contained in the inner portion is unable to escape, and consequently explosion and cracks in the lining will result.

Shape of Lining.

As regards the internal shape of the lining, there are at present various opinions held. It is, however, an indisputable fact that the shape and general arrangement of the lining as shown in Fig. 1 not only gives the best results but is more endurable and reliable against the action imparted by the process of melting, and repairs and daubing can be effected in the most simple way. The brickwork from the charging floor down to where the melting zone begins is absolutely straight, whilst from here down to the bottom the cupola is slightly tapered inwards. This shape has two special objects: the air can more easily be forced to the centre of the cupola, and the amount of coke on the bed is thus somewhat reduced. Fig. 2 shows the internal shape of a cupola still often found in use. The lining is drawn or tapered at level of the tuyeres rather suddenly, which should again serve the purpose of easy access of air into the middle of the cupola, whilst the lower portion allowed for the bed is considerably widened again, which, of course, can only be considered as a disadvantage. Besides, all such sudden offsets and alterations as at "a" and "b" in the shape of a cupola only result in excessive melt-

ing away of the lining and difficulty in maintaining such a shape.

A still more disadvantageous shape of lining is shown in Fig. 3. This is still employed in a good many foundries, and the reason put forward to warrant such a shape is that the effect of the sudden enlargement of

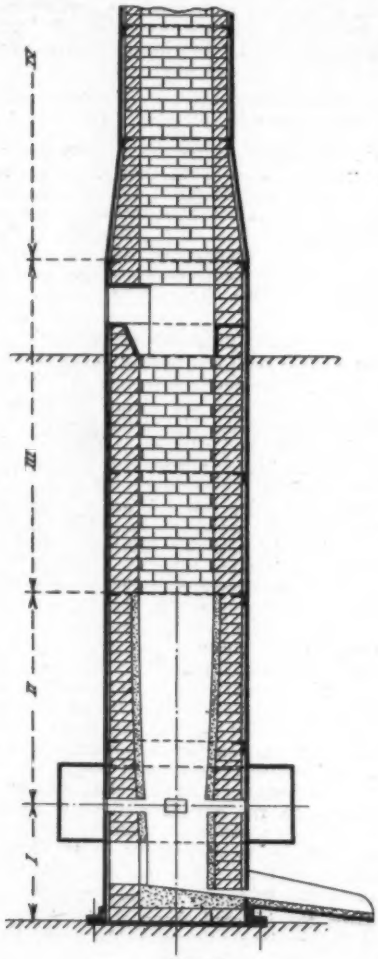


Fig. 1.

the diameter below the tuyeres is to prevent the iron running into the tuyeres. In practice, however, this arrangement will act contrary, namely, the iron descending in form of drops will glide along the tapered portion "c," following along the upper side into the tuyeres, and especially so if the tuyeres are somewhat inclined.

There are quite a number of other shapes, in fact some of them quite fancy shapes, which in actual practice have no other purpose than to complicate and retard the melting process.

Nature of Fluxes and Formation of Slag.

On dealing with this subject, it is more than difficult to realise why the average foundryman does not better acquaint himself with this all-important subject, knowing well that fluxes and slag so greatly influence the melting process. It is an acknowledged fact that the mixing of iron by analysis has in recent years gained great favour amongst scores of practical foundrymen, and one naturally asks, why not treat slag and fluxes in a similar more-or-less scientific method? That is to say, why not charge your fluxing material—which is an absolute necessity—according to the law of practised metallurgy? Although great care may be taken in mixing the various grades of iron, unsatisfactory results may yet occur owing to using the improper quality and quantity of flux, or if used in proper quantities, yet used in an improper manner. There are hundreds of

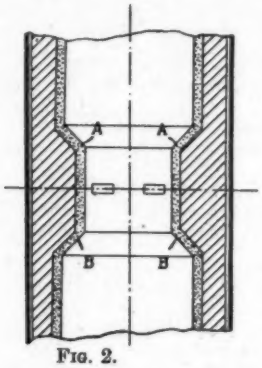


Fig. 2.

foundrymen in this country at the present time either using no flux at all or using a flux wrongly, charging it in such a way as to exactly counteract that which it should perform. For instance, the writer recently visited a large foundry where it was the usual practice that the limestone charged after every coke charge should be carefully placed all round the walls of the cupola in a ring-like manner, as this method was supposed to keep the lining clean. An elementary knowledge of chemistry is quite sufficient to show the destructive effect of a basic slag acting on a lining of silica-ganister, and therefore of acid

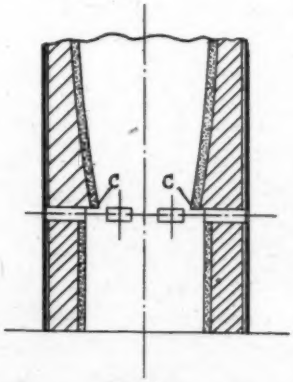


Fig. 3.

nature, unless by mere chance the ensuing slag in the cupola and the lining were both either of basic or acid nature. The following formula indicates the effect :—

$$SiO_2 + CaCO_3 = CaSiO_3 + CO_2.$$

That is to say, the lime will dissolve the silica of the lining, and therefore destroy and melt away the lining rapidly, apart from the fact that the coke, or rather the coke ash, in the centre of the cupola is prevented from forming a fluxable slag, and thereby a certain percentage of ash in the coke has no

opportunity to combine with the lime. It is a well-known fact that the average foundryman does not care for a display of chemical formula, but at the same time it is very difficult to handle this subj... without using at least the most elementary formulas encountered by the melting process.

Nature and Formation of Cupola Slag.

General Properties.—Cupola slag may be either of basic, neutral or acid nature.

The term "basic" refers to combination of oxygen with a metallic element such as—

$$Ca + O = CaO = \text{oxide of calcium}$$

or

$$Fe + O = FeO = \text{oxide of iron,}$$

whilst an acid compound is the combination of oxygen with a non-metallic element, such as

$$\text{Silicon} = Si \text{ or Carbon} = C.$$

$$Si + 2O = SiO_2 = \text{silica.}$$

or

$$C + 2O = CO_2 = \text{carbonic acid.}$$

Under the term "neutral" is is understood that the basic and acid oxides are balanced in about equal proportions, and therefore will neither act as a base nor as an acid. Now, supposing such a basic oxide as lime is brought together with an acid oxide such as silica at a sufficiently high temperature, then they will again combine, thereby conforming to a certain formula, and result in slag.

$$SiO_2 + CaO = CaSiO_3 = \text{calcium silicate.}$$

The acid silica, therefore, has formed with the lime, which is a base, another compound called calcium silicate. It is the great chemical affinity which exists between acid and basic that causes the chemical combination, and the slag thereby formed may be either of basic, acid or neutral nature, according to the proportion in which the metallic oxide combines with the acid oxide.

The components of cupola slag may be classified as follows :—

Acid Compounds.		*Basic Compounds.*	
Silica	$= SiO_2$	Lime	$= CaO$
Sulphuric acid	$= SO_3$	Alumina	$= Al_2C_3$
Phosphoric acid	$= P_2O_5$	Iron oxide	$= FeO$
		Manganese oxide	$= MnO$
		Potash	$= K_2O$
		Soda	$= Na_2O$

For practical purposes, however, P_2O_5 and SO_3, also K_2O and Na_2O, classified respectively under acid and basic, may easily be omitted because their respective percentages are invariably small and of little influence from a practical point of view.

The combination of metallic oxides with silica in cupola slag may further be divided into three different and distinctive grades, according to the ratio of oxygen in the acid, and the ratio of oxygen in the base. Supposing RO to represent the metallic oxide and silica (SiO_2) the acid oxide, then the general properties of cupola slag may be tabulated as follows :—

	Metallic Oxide.	Silica.	Compound.	Grade.	Nature.	Ratio of Oxygen. Base.	Acid.
I. ...	$4RO$ +	SiO_2 =	$4SiO_6$ =	Subsilicate	Basic	2 :	1
II. ...	$2RO$ +	SiO_2 =	R_2SiO_4 =	Monosilicate	Neutral	1 :	1
III....	RO +	SiO_2 =	$RSiO_3$ =	Bisilicate	Acid	1 :	2

Oxide of iron (when in form of ferric oxide (Fe_2O_3) and alumina, however, conform to a somewhat different formula, as for instance in the case $2RO_3 + 3SiO_2 = R_4Si_3O_{12}$.

Alumina has, besides, another characteristic point, namely, it acts sometimes as an acid and also as a base. The former is the case, more or less, if the percentage of silica is low, but in cases where silica exceeds, say, 50 per cent., alumina may be considered to act as a base, and, in fact, as regards cupola slag, may invariably be classified under basic compounds.

It must, however, be perfectly understood that the above-mentioned proportions—2 : 1, etc.—are not always absolutely definite, but vary in their respective silicate grade to some extent, viz. :—

Grade.	Proportion.	Variations.
Subsilicate ...	2 : 1	0.50 to 0.80
Monosilicate ...	1 : 1	0.75 to 1.25
Bisilicate ...	1 : 2	1.25 to 2.25

Nearly all samples of ordinary cupola slag, considering their general properties and the comparatively low melting temperature of the cupola as compared with the blast furnace or the Siemens-Martin furnace indicate that the slags have to be classified either as subsilicates (basic slag), or monosilicates (neutral slag); based, of course, on the comparative amount of oxygen in the acid oxide and in the basic oxide.

In turning now to the practical side of the question regarding cupola slag, it is, of course, necessary to know the approximate composition of the various raw materials charged, further what material and to what extent same will produce slag, etc. Slag, as it occurs in cupola melting and without the addition of any fluxing material such as lime, fluorspar, etc., is of a more or less pasty nature (of the bisilicate type), difficult to fuse, and will contain an excess of oxide of iron, and is, therefore, a loss to the foundry. A certain amount of fluxing material will, therefore, be necessary in almost every instance in order to form an easy-flowing slag to be drawn off at certain intervals through the slag-hole of the cupola, that is to say, the bisilicate will have to be transformed during the melting process into a neutral monosilicate or a basic sub-silicate.

Formation of Slag is caused

(1) Through oxidisation of the iron charged, especially Fe, Si and Mn.

(2) Through sand and dirt adhering to the pig-iron and scrap.

(3) Through charging of fluxes such as limestone, fluorspar, etc.

(4) Through the ash contained in the coke.

(5) Through continual melting away of the cupola lining.

The following is a calculation on hand of an example showing the necessary amount of flux required in each of the five items mentioned above, and in summing up same the writer will give the total amount of fluxing material necessary per ton of iron melted.

EXAMPLE.

Slag to be produced—MONOSILICATE.

I. Percentage of ingredients of the molten metal and subject to oxidisation :—

Fe	=	93 per cent.
Si	=	2.5 ,,
Mn	=	1 ,,

II. Amount of sand adhering to pig-iron = 1 %
,, ,, ,, machine scrap = ½ %
,, ,, ,, shop scrap = 1½ %

Taken in equal proportions amount of sand and dirt=1 per cent., or 22.5 lbs. per ton of iron.

III. Ratio of iron charges to ratio of coke charges = 10 : 1 including bed
or = 224 lbs. coke per ton of iron.
Amount of coke ash = 10 per cent.

Composition of coke ash :—

SiO_2	=	48 per cent.
Al_2O_3	=	22 ,,
Fe_2O_3	=	27 ,,
CaO	=	9 ,,
MgO	=	2.5 ,,
SO_3	=	0.5 ,,

IV. Composition of limestone :—

SiO_2	=	2.5 per cent.
Al_2O_3	=	1.25 ,,
Fe_2O_3	=	1.5 ,,
CaO	=	50 ,,
MgO	=	2 ,,
CO_2	=	42.75 ,,

V. Composition of cupola lining :—

SiO_2	=	75 per cent.
Al_2O_3	=	20 ,,
Fe_2O_3	=	5 ,,

Slag Caused Through Oxidation of Fe, Si and Mn.—By long experience it has been found that the oxidation in cupola melting is as follows :—

Iron	=	2 per cent.
Silicon	=	15 ,,
Manganese	=	40 ,,

Therefore, 2 per cent. iron oxidised per ton of metal (93 per cent.=2,150 lbs.)=73 lbs; 15 per cent. silicon oxidised per ton of metal (2.5 per cent.=56 lbs.)= 9 lbs.; 40 per cent. manganese oxidised per ton of metal (1 per cent.=22.5 lbs.)=9 lbs.

1. 56 parts of iron equal 72 parts of FeO ;
   73 lbs. ,, ,, 55 lbs. of FeO.
2. 28 parts of Si equal 60 parts of SiO_2 ;
   9 lbs. ,, ,, 19 lbs. of SiO_2.
3. 48 parts of Mn equal 64 parts of MnO ;
   9 lbs. ,, ,, 12 lbs. of MnO.

320 parts of Fe_2O_3 equal 180 parts of SiO_2 ;
55 lbs. ,, ,, 30 lbs. of SiO_2.
128 parts of MgO equal 60 parts of SiO_2 ;
12 lbs. ,, ,, 5.5 lbs. of SiO_2.

The basic oxides, amounting to 67 lbs., will combine with 30+5.5=35.5 lbs. of silica, but the latter amounts to only 19 lbs., which equals 35 lbs. of basic oxides. We have here also a surplus of basic oxides of 67 - 35=32 lbs., and therefore it will be seen that the slag produced through oxidation is more than self-fluxing.

Slag Caused Through Oxidation by the Adhering Sand and Dirt.—This has been estimated to be roughly 1 per cent. of the iron charges and consists solely of silica. Therefore 1 per cent. of 2,240 lbs.= 22.4 lbs. of silica. Now under calculation 1 we have a surplus of about 32 lbs. of Fe_2O_3 and 2.5 lbs. of MgO; but 32 lbs. of Fe_2O_3=21.5 lbs. of silica and 2.5 lbs of MgO=1.5 lb. of silica, or= 23 lbs. of silica in all.

34.5 lbs. of surplus basic oxide (as under 1) will combine or flux 23 lbs. of silica.

The 1 per cent. of sand (=22.4 lbs.) adhering to the iron charges are therefore fluxed by the surplus basic oxide, as mentioned under No. 1.

Slag Caused Through Coke Ash.—Amount of coke ash=10 per cent. or 22.4 lbs. per ton.

As will be seen from the analysis, the ash contains acid and acid oxides in about equal percentages, and it remains therefore to be seen in how far the coke ash is self-fluxing.

SiO_2	=	48	per cent. of 22.4 lbs.	=	10.85 lbs.
Al_2O_3	=	18	,,	22.4 ,,	=	3.95 ,,
Fe_2O_3	=	22	,,	22.4 ,,	=	4.85 ,,
CaO	=	9	,,	22.4 ,,	=	1.95 ,,
MgO	=	2.5	,,	22.4 ,,	=	0.65 ,,
SO_3	=	5	,,	22.4 ,,	=	0.12 ,,

The ash contains 48 per cent. of SiO_2=10.85 lbs. The basic oxides, however, will assist the fluxing of the silica to some extent.

I. Al_2O_3 = 18 per cent. of 22.4 lbs. = 3.95 lbs.

$2Al_2O_3 + 3SiO_2 = 208 : 280 = 3.95 : X$

$$X = \frac{180 \times 3.95}{208} \quad \ldots \quad \ldots \quad = 3.4 \text{ lbs.}$$

II. Fe_2O_3 = 22 per cent. of 22.4 lbs. = 4.85 lbs.

$2Fe_2O_3 + 3SiO_2 = 320 : 280 = 4.85 : X$

$$X = \frac{180 \times 4.85}{320} \quad \ldots \quad \ldots \quad = 2.7 \text{ lbs.}$$

III. CaO = 9 per cent. of 22.4 lbs. = 1.95 lbs.

$2CaO + SiO_2 = 224 : 60 = 1.95 : X$

$$X = \frac{1.95 \times 60}{224} \quad \ldots \quad \ldots \quad = 0.5 \text{ lbs.}$$

The percentage of MgO and SO_3 are so small that same can have no material influence on the slag.

Basic oxides contained in the coke ash will flux the following amount of silica :—

I.	Al_2O_3	=	3.4 lbs.
II.	Fe_2O_3	=	2.7 lbs.
III.	CaO,	=	0.5 lbs.
		Total =	6.6 lbs. of Silica.

The silica in the coke ash being 10.85 lbs. less 6.6 lbs. leaves 4.25 lbs. of silica to be fluxed by lime.

Now the next step will be to calculate the amount of lime (CaC) required to flux the 4.25 lbs. of silica contained in the coke ash. In referring to the analysis set out in this example, it is for practical purposes, and for limestone of similar composition, quite sufficient and safe to assume that the basic oxides in the limestone apart from CaO are quite capable of fluxing the silica present in limestone.

$Al_2O_3 + Fe_2O_3 + MgO$=4.75 per cent., and this 4.75 per cent. of basic oxides is more than sufficient to flux the 2.5 per cent. silica in the lime. 4.25 lbs. of silica would therefore require on pure lime—$SiO_2 + 2CaO$= $60 : 112 = 4.25 : X$

$$X = \frac{112 \times 4.25}{60} \quad = \quad 7.75 \text{ lbs.}$$

But in addition to this it is further necessary to allow a small amount of lime for the absorption of S, and lime conforms with S to the following formula :—

$S + CaO = 32 : 56 = 1 : X$

$$X = \frac{56}{32} \quad = \quad 1.75 \text{ lbs.}$$

Amount of lime to flux coke ash=7.75 lbs.
Amount of lime to absorb S =1.75 lbs.
Lime =9.50 lbs.

Now as the last item there remains the amount of slag caused through the melting away of the cupola lining during every heat. This of course depends on the quantity of lining or daubing melted away after each heat, and this in turn on the quantity of such repair-material applied for a given size of cupola, and the chemical composition of the material.

Monosilicate slag, as is the case in this example, is best suited for a lining having the analysis as given above.

Suppose the cupola melts 25 tons per heat and the quantity of lining of the above composition is 2 cwt., then the amount of lining per ton equals 9 lbs., which

equals according to analysis:—SiO_2, 6.75 lbs.; Al_2O_3, 1.82 lbs.; Fe_2O_3, 0.50 lbs.

Here again the basic oxides will assist the fluxing of the silica:—$2\ Al_2O_3 : 3\ SiO_2 = 208 : 180 = 1.8 : X$

$$X = \frac{180 \times 1.8}{208} = 1.5 \text{ lbs.}$$

$2\ Fe_2O_3 : 3\ SiO_2 = 320 : 180 = 0.50 : X$

$$X = \frac{180 \times 0.50}{320} = 0.30 \text{ lbs.}$$

The silica fluxed equals 1.5 + 0.3, or 1.8 lbs. by basic oxides in the cupola lining. There also remain 9 − 1.8 = 7.2 lbs. of silica to be fluxed by lime.

$$SiO_2 : 2\ CaO = 60 : 112 = 7.2 : X$$

$$X = \frac{112 \times 7.2}{60} = 13.4 \text{ lbs.}$$

Total amount of lime required per ton of iron melted:—9.5 + 13.4 = 22.9, or say 23 lbs. of lime, which equals approximately 40 lbs. of limestone. This amount of limestone is calculated on the basis of a monosilicate, whilst for a subsilicate the quantity of limestone would be about 25 per cent. to 50 per cent. more, and in case of a bisilicate or acid slag, about from 25 per cent. to 50 per cent. less than the amount calculated above.

The figures given here are a fair average for the three different grades of slag under ordinary cupola practice. No doubt, however, a great number of foundrymen will argue that the calculations as given above are too slow, and for the average foundryman too theoretical. Admittedly this is the case, if such calculation would have to be made for every heat, but as a matter of fact, the amount of coke ash, the purity of the limestone and the chemical composition of material for lining the cupola should, under strict supervision as regards buying this raw material, only vary within reasonable limits and may remain practically constant. Further, oxidation of iron can under normal conditions vary very little, whilst iron containing, say, 3.0 silicon may require about from 3 to 4 lbs. more limestone per ton of iron than would be the case by melting an iron with only about 1.5 per cent. silicon. It cannot, however, be urged too much to be on guard against charging, especially shop scrap, with large quantities of sand and dirt adhering to the material.

Having based and calculated the amount of limestone required per ton of iron with respect to the raw material usually available, there ought not to be the slightest difficulty in altering the quantity of limestone should one or several of the five slag-producing agents alter its respective chemical composition.

The Keith-Blackman High-Pressure Blower.

The centrifugal blower is by some considered likely to displace the positive form of blower for cupola work. It is claimed for the centrifugal blower that by its use the metal is brought down at a much more even temperature than is possible with blowers of the positive type. This is due to the fact that the former maintains a constant pressure, so that when the cupola is full, a reduced quantity of air is forced through, thereby promoting slower combustion, and ensuring that the metal, although falling through a greater depth of fire, is not unduly heated. On the other hand, when the charge in the cupola sinks, the centrifugal blower sends through an increased volume of air, causing a more rapid combustion, with the result that the temperature of the metal is kept up, despite the fire being shallower. This unique effect is not obtainable with the positive blower, which delivers a practically uniform volume of air, irrespective of the depth of fire in the cupola, so that with its use the temperature of the metal is apt to vary, being too fierce when the charge is high, and too cool when the fire has sunk appreciably.

It is also worthy of note that the construction of the centrifugal blower lends itself suitably to direct combination with an electric motor, forming a very

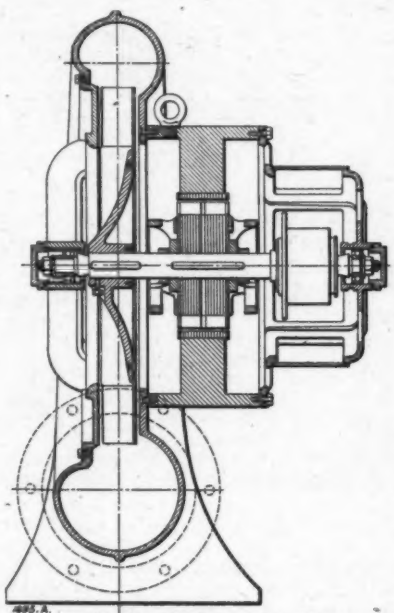


FIG. 1.

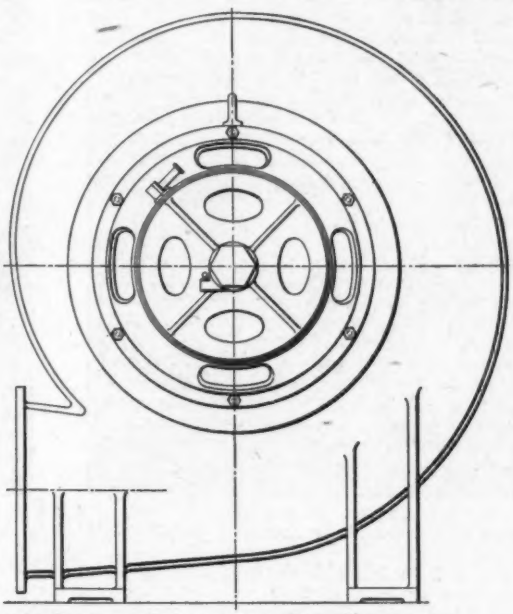


FIG. 2.

THE KEITH-BLACKMAN HIGH-PRESSURE BLOWER; SECTIONAL AND SIDE VIEWS.

compact and highly efficient unit, which commends it to the foundry manager who is adopting electric power.

The employment of the centrifugal blower also brings about economy in running cost, as for the same work and equal conditions it requires less power to drive, and fewer maintenance charges than the positive form of blower.

The centrifugal blower manufactured by Messrs. James Keith & Blackman Company, Limited, of Farringdon Avenue, E.C., is illustrated in Figs. 1 and 2. As will be noted, the motor is self-contained with the fan casing. Invariably this motor is of the enclosed ventilated pattern, with forced ventilation, so arranged to preclude the lodgment of dust in the motor itself. The fan or impeller consists of a sheet-steel disc to which the blades are electrically welded, and all parts accurately balanced. There is no side pull or end thrust on the ball bearings, which are mounted in dust-proof housings, so that there is little or no wear, the blower and motor being designed to run for very long periods without giving trouble.

Our representative recently visited the works of Messrs. Thos. Broadbent & Sons, Limited, Huddersfield, and Messrs. Henry Brook & Company, Limited, Huddersfield, and in each case inspected a No. 4 Keith-Blackman motor-driven blower, with 8-in. outlet, designed to bring down four tons of metal per hour when running at 2,850 revs. per minute, delivering 2,700 cubic feet of air per minute at 22½ in. pressure by water-gauge. The motor at full load takes 12,000 watts, which gives the combined apparatus an efficiency of 60 per cent.

Fig. 1.—Safety Switch in the Foundry of the Brown & Sharpe Manufacturing Company.

At Messrs. Broadbent's works the electrically-driven centrifugal blower has displaced a steam-driven unit of the positive type, and is carried on a wall-bracket at the entrance to the foundry; the blower is well above its work, and, indeed, has sometimes to be throttled down by a valve in the blast-main leading to the cupola. Although they are entirely unprotected from dust, our representative was informed that the blower and motor have given the utmost satisfaction, no trouble whatever being experienced during the several months the plant has been at work. At Messrs. Brooks' foundry the Keith-Blackman blower has displaced a large steam-driven fan, which for belt repairs alone involved a considerable annual outlay, apart from the loss sustained through the delays incidental thereto.

We understand that Messrs. Keith & Blackman have successfully installed their electrically-driven centrifugal blowers in place of the positive type hitherto in use in the foundries of a number of other well-known engineering establishments.

The Prevention of Industrial Accidents.

In the course of the discussion on the Paper, entitled "The Mechanical Engineer and the Prevention of Accidents," presented recently before the American Society of Mechanical Engineers, some interesting appliances were described. One speaker, dealing with the plant of the Brown & Sharpe Manufacturing Company, said that in the polishing department, often one of the most unhealthy places to be found around the shop, exhaust pipes are connected with every polishing stand, thereby carrying the dust entirely out of the room.

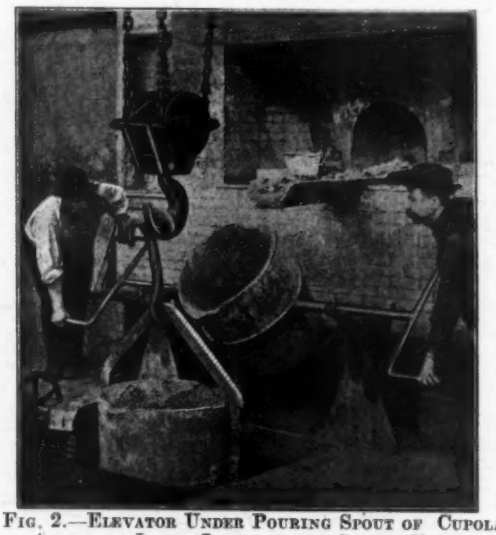


Fig. 2.—Elevator Under Pouring Spout of Cupola, Allowing Large Ladles to be Safely Filled.

The use of a temporary, wooden guard to protect exposed gears on old designs of gear-cutting machinery is also a feature of the plant. In Fig. 1 is shown an interior view of the Brown & Sharpe Manufacturing Company's foundry, which shows an overhead track for handling ladles and castings, which is provided with switches, so safeguarded that when they are open the trolley is prevented from running off and falling on the workmen. In Fig. 2 is shown an elevator underneath the pouring spout of a cupola in the same foundry, which is lowered when ladles are being filled with molten iron and is elevated after the ladles have been removed, thereby closing the opening in the floor. When hand ladles are being filled the platform of the elevator is raised so that there will be no opening into which a workman might fall. This can also remain closed when the cupola is not in use.

Institute of Metals.

Annual Autumn Meeting.

The annual autumn meeting of this Institute was held at Newcastle-on-Tyne on September 20, 21, and 22. The meeting was opened at 10 a.m. on Wednesday, when the members were welcomed at Armstrong College by the Lord Mayor of the city, Sir W. H. Stephenson, and the Local Committee, after which a series of papers were read and discussed, Sir Gerard A. Muntz, Bart. (President), being in the chair. In the afternoon members visited shipbuilding, engineering, metallurgical, and electrical works in the neighbourhood. On Thursday, September 21, papers were read and discussed at a morning session of the Institute, and in the afternoon there were further visits to works. For September 22, the Tyne Improvement Commissioners placed a steamer at the disposal of the Local Committee for a trip to the mouth of the river and back.

The following are abstracts of some of the papers presented at the meeting :—

The Electrical Conductivity and Constitution of Alloys.

By W. M. Guertler, Ph.D.

The aim of this Paper, which is one mainly of theoretical interest, is to call attention to the property of electrical conductivity in its bearing upon the practical determination of the constitution of alloys. The so-called "equilibrium diagram" for alloys is now almost universally accepted as the basis for any systematic study of the properties of alloys, and hence it is of great importance to be able to construct it accurately, and to have a thorough knowledge of it. The relationship between concentration, temperature and any given property—electrical conductivity, specific volume, magnetism, etc.—is best and most clearly brought out by the employment of a co-ordinate system in those dimensions. Thus taking concentration and temperature as the base, we can erect ordinates from it whose lengths are proportional to the numerical values of the property under consideration, and so obtain a series of intersecting curved surfaces, each of which corresponds to a particular phase-region of the equilibrium diagram. The converse problem is one of great importance, viz., that of obtaining the equilibrium diagram (when it is unknown) by projection from these surfaces on to the basal plane. The best-known method, and one which has been hitherto, and is still most universally employed for the determination of the equilibrium diagram, is that known by the name of "thermal analysis," in which special account is taken of the variations in the "total heat" of the systems under consideration. The author discusses at length the limitations of "thermal analysis," and in particular explains why it fails in those cases where, as so often happens in practice, a state of complete stable equilibrium is unattainable within a comparatively short interval of time. The respective merits of electrical conductivity and of specific resistance measurements are set forth and illustrated by numerous examples from practice.

The Failure of a Brazed Joint.

By Professor H. Louis, M.A., B.Sc., Assoc.R.S.M.

The Paper gives a brief account of the investigation of the cause of a failure in the braze of a steam pipe on a steamer, undertaken at the instance of the Board of Trade. The author shows that the failure was due to corrosion following certain well-defined lines in the brass, and he traces the cause of these lines to the presence of small quantities of lead and tin in the original brazing spelter. The lead-tin alloy separating out between the crystals of brass formed planes of weakness that gave access to the corroding solutions, and this brought about the gradual corrosion of the entire brazing material.

The Mechanical Properties of Hard-Drawn Copper.

By D. R. Pye, B.A.

In this Paper the lack of any satisfactory definition of standard hard-drawn copper is pointed out. Although the Post Office specification is highly satisfactory for the sizes of wire used in telephone and telegraph construction, it is quite unsuitable for larger sizes. The various definitions adopted from time to time are reviewed, and it is suggested that the one at present adopted by the Engineering Standards Committee, viz., "The term hard-drawn copper wire shall apply to copper wire which does not elongate more than 4 per cent. on a gauge length of 10 inches when broken by tension," though not contradictory of the properties of hard-drawn copper, is unsatisfactory, since a specification should preferably fix a *minimum* elongation as a safeguard against the wire becoming brittle. An important point is that tensile strength per square inch and elongation at fracture both depend on the diameter of the wire.

Experiments are described confirming a suggestion made by Mr. A. P. Trotter that this tensile strength per square inch diminishes with increase of diameter according to a linear law. It is also shown that the elongation at fracture for similarly manufactured wires depends very much on the diameter, being considerably greater for larger sizes of wire. In view of these experiments it is suggested that a satisfactory definition of hard-drawn copper wire would fix a minimum tensile strength per square inch given by the formula

$$T = 30 - 20\ D,$$

and a minimum elongation per cent. at fracture given by the formula

$$e = 5\ D$$

where D = diameter in inches.

This specification would hold good for all sizes up to 0.5 in. diameter. Finally this suggested definition is compared with the specifications of the American Society for the Testing of Materials, and an appendix is added giving the results of some recent experiments in America showing the effect of hard-drawing upon the electrical properties of copper.

The Alloys of Aluminium and Zinc.

By Walter Rosenhain, B.A., D.Sc., and S. L. Archbutt, A.I.C (both of the National Physical Laboratory).

The Paper describes a detailed investigation of the constitution of the alloys of aluminium and zinc which was undertaken in connection with an extended research on the light alloys of aluminium—the latter research being carried out by the authors on behalf of the Alloys Research Committee of the Institute of Mechanical Engineers. The present Paper describes the detailed thermal and microscopic study of the alloys. A long series of cooling-curves were taken at a very slow rate of cooling, and in many cases the ingots of the alloys were subjected to prolonged

annealing before the cooling curves were taken. The microscopic examination of the slowly-cooled alloys was supplemented by the study of specimens which had been annealed and quenched at various definite temperatures. The results are embodied in an equilibrium diagram which differs considerably from the diagram of Shepherd, which has hitherto been accepted; these differences result from the discovery of the existence of the definite compound Al_2Zn_3, which has a stable existence only between 443 deg. C. and 256 deg. C.; in the majority of the alloys this compound is only slowly formed by a reaction between crystals of zinc and an aluminium-rich mother liquor at 443 deg. C. At 256 deg. C., however, the compound again decomposes into practically pure zinc and an aluminium-rich solid solution; this decomposition is, however, of special interest because it produces a finely-laminated constituent closely resembling the "pearlite" of carbon steels. The research has been carried out in the Metallurgy Department of the National Physical Laboratory.

Further Notes on the Nature of Solid Solutions.

By C. A. Edwards, M.Sc.

The main object of this Paper is to deal with a few points of interest and difference raised in the discussion on a previous Paper by Mr. Edwards on the same subject, and also to stimulate further discussion on a matter which is not purely of scientific interest. The main conclusion in the previous Paper was that "solid solutions of two metals or intermetallic compounds are intimate crystalline mixtures, and whilst the crystals are so small that the mass appears quite homogeneous, they are, nevertheless, sufficiently large to retain their identity." The principal objection to this view was that it is opposed to the Phase Rule. A general review of solutions—gaseous, liquid and solid—is given in the present Paper, after which review the author concludes that the above idea does not conflict with the Phase Rule, and in fact the Phase Rule was never intended to extend in its application to the internal nature of a constituent.

As regards solutions in general, Mr. Edwards holds that gaseous, liquid and solid solutions are members of the same family, the different states of these members being due to differences in their molecular aggregation. In all cases of true solution the molecules of each component remain unchanged, *i.e.*, there is no association of dissimilar molecules, *e.g.*, there can be no association of the molecules of a salt with those of water, when in the form of an aqueous solution, unless it results in the formation of a new compound. Thus in the case of gaseous solutions a uniform composition is maintained by the physical forces existing between what may be regarded as simple molecules; in liquid solutions a constant composition throughout the mass is maintained by the forces existing between dissimilar groups of molecules, but each individual group consists of only one kind of molecule. In the case of solid solutions, equilibria are maintained between the very small crystals of each component metal or intermetallic compounds.

With the expression $F=C+2-P$ representing the Phase Rule, solutions come under the head of homogeneous equilibria, but that equation should not be applied to disprove the Author's conception of the internal nature of solutions, because, with it, the assumption is tacitly made that a solution is homogeneous, and thereby judgment is passed before the evidence is considered.

From a general point of view the term "solid solution" is to be preferred to "mixed crystals," but whichever term is used, the Author considers that such bodies consist of extremely small crystals of two or more metals or intermetallic compounds; and whilst these crystals are ultra-microscopic, they retain their individual properties.

With regard to the practical aspect of this interesting question, the author will only say that with this conception, and so far as he is aware, with this only, can the discontinuity in the mechanical properties of the α brasses (discovered by Bengough and Hudson) which occur at 470 deg. C. be explained. Further, many other facts which are still not understood become quite reasonable after accepting this theory.

It will be seen that this note deals more with the bearing of the Phase Rule upon the question; other less vital objections have for the moment been left out of consideration, because the author believes they were made as a result of some slight misunderstanding, and also because it is first necessary for members interested in the subject to decide whether they will accept the author's theory as being in agreement with well-known physical laws.

Vollume Changes in the Alloys of Copper with Tin

By J. L. Haughton, M.Sc., and Professor T. Turner, M.Sc.

The work of which Mr. Haughton presented an account may be regarded as a continuation of previous researches on the changes in length which occur in a cast bar during and after solidification. To these investigations Picken, Simpson, Murray, Hague, Ewen, and Coe (former Research Students in the University of Birmingham) have contributed. The method employed has been that of applying an extensometer to one end of a cast bar while the other end was kept fixed. With a single substance, such as a pure metal or a definite compound, the extensometer does not appear to act until immediately after solidification has occurred, and contraction thereafter proceeds regularly. But where internal changes take place due to such causes as the separation of a constituent, or of a eutectic, from the solid matrix, such changes are indicated by changes in length of the bar. The separation of a constituent is generally accompanied by an expansion, while if the interval between the solidus and the liquidus is considerable the expansion of the cast bar is also generally large, and it extends over a considerable interval of time.

The apparatus employed has been modified by the Author in order to allow a single operator to observe both pyrometer and extensometer readings at the same instant, and to record these results by means of a chronograph on a paper tape. In a few cases tin-copper alloys have been already examined by Ewen and by Wüst, and it is desirable to note that the agreement between the Author and these previous workers is generally quite satisfactory.

The Paper clearly shows that there are four maxima in the expansion curve, and that three of these, with about 10, 46, and 65 per cent. of tin respectively, agree with the "crystallisation interval" as determined from the accepted equilibrium diagrams. The maximum observed at 30 per cent. of tin is not easy to explain, though it may be pointed out that the equilibrium diagram at this point is exceptionally complicated, and that perhaps the "crystallisation interval" should extend down to 500 deg. C., in which case the maximum would fall into proper order. Mr. Haughton records the fact that certain of the intermediate alloys of the series are remarkably insoluble in acids and ordinary solvents. Hence the analysis presented unexpected difficulties. These were overcome by the use of bromine, and this simple and direct method of solution may be of use to other investigators of the tin-copper series.

Non-Ferrous Metal in Railway Work.

This paper is dealt with at length on another page.

Non-Ferrous Metals in Railway Work.*

By George Hughes, M.Inst.C.E., M.I.Mech.E.†

The author's object is to lay before the members the practical side of the subject, stating difficulties in manufacture, and some means of overcoming them; wear and tear; and the life of the various non-ferrous component parts of rolling stock, with the object of eliciting a combined practical and scientific discussion, and specific points in the Paper will be emphasised in order to bring this out.

A section on some of the various brass-foundry alloys used as brass castings on the Lancashire and Yorkshire Railway rolling stock has been added, together with information regarding manufacture, composition, tests, and life, under everyday conditions of railway service.

Finally, a short account of the bearing metals used, under the name of white metals, and other alloys has been included, together with a notice of non-ferrous metals in the carriage and wagon departments.

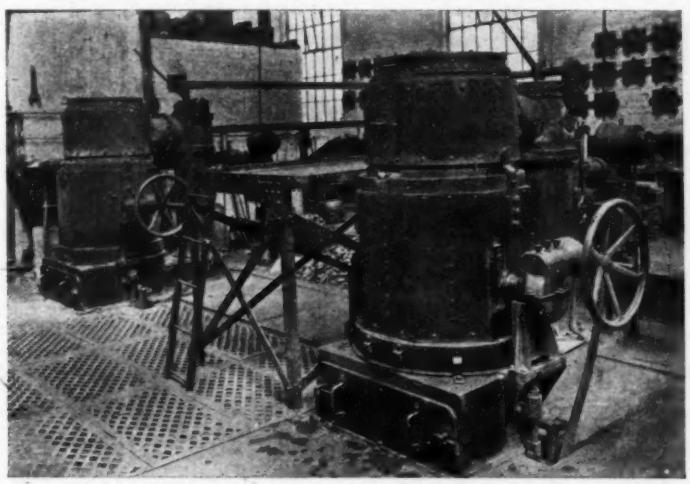


Fig. 1.—Tilting Crucible Furnace for Melting Alloys.

Copper Alloys.

Before considering specifically these alloys, the author thinks it will be interesting to preface this section with the method of dealing with the large amount of scrap, which, in all large establishments, is of considerable quantity and importance per annum. This comprises articles which, worn out in service, are sent in to the central depôt for utilisation and disposal. The economical working up of this material presents a problem to those responsible for the brass-foundry costs and workings, and some account of its disposal may be of interest.

Considered under the headings of "Home" or "Rolling Stock" scrap, and "Outside" material from all other departments, the first is fairly readily accounted for by separating all articles whose composition is known, and using them over again as an addition to the new mixture. Slide valves, for instance, are branded by distinguishing marks cast on, and are used again together with the shop gits in proportion of half old valves and half other constituent metals, these latter not usually new ingots. Scrap of unknown value from "Outside," as well as borings and turnings from the machine shops, cannot be dealt with so directly. Brass borings received from the machine shop are generally contaminated with iron and steel turnings and sweepings, and also may be mixed with white metal from the boring machines.

In order to separate these ingredients, borings containing white-metal alloy are heated on a sloping hot plate over a coke fire, so inclined that as the white metal softens and melts, it gradually runs off into a receptacle, leaving the brass to be scraped over the top of the plate.

The whole of the brass borings received for melting-up are passed over a magnetic separator to extract the iron particles, which are collected and taken away. This makes for cleaner castings and more homogeneous material.

It is then customary to work this up by melting in an air furnace of 25 cwts. capacity, fired by producer-gas. A definite composition is arrived at, and subsequently cast into iron-chill moulds in the form of ingots. Such ingots, after their composition is ascertained by analyses, can then be profitably used in many directions, by forming the basis of fresh charges, along with other small amounts of new metal, to give the desired result.

With the scrap is charged 400 lbs. of scrap copper shearings obtained from old firebox plates in the boiler shop, and 30 lbs. of block tin, the whole charge amounting to 20 cwts. This is melted in two to three hours, and covered with a small quantity of sawdust to reduce oxidation. Samples are withdrawn and their fracture noted, and slight additions of tin or other metal made to bring them to one standard

* Abstract of Paper read before the Institute of Metals.
† Chief Mechanical Engineer, Lancashire and Yorkshire Railway.

fracture; then the charge is tapped out into a 5 cwt. ladle and run into ingots. As showing how closely a charge can be represented by indication of fracture tests, analyses in Table I. are given of consecutive casts as determined by drillings.

This metal is also used for the smaller brass axle-boxes, radial and tender brasses, and for this purpose is poured direct into green-sand moulds, and also cast into ingots to form the bulk of many mixtures.

The metal for the ordinary run of castings is melted in a modern type of tilting crucible furnace (Fig. 1) of 400 lbs. capacity, fired by coke and worked by air-blast from a small motor-blower attached to the furnace. The crucible is permanently fixed in the furnaces, thereby reducing the risk of cracking due to cooling and handling, and careful records of 45 crucibles show an average life of 39.6 heats before renewal. This method is found to be a distinct improvement over the usual 120-lb. crucible heated in a coke "pot" fire and withdrawn for casting purposes, both in life of crucible and amount of coke used per cwt. of melted metal.

Loss in Melting.

Careful check-weighings have been made of metal used and melted, together with loss due to oxidation. The various charges of metal described in Table II. have been poured into the ladle with an average loss in furnace of 1 per cent., excepting charge No. 4, containing a high percentage of zinc, which came out at 2.9 per cent. Also, it may be stated that 450 lbs. charges can be cast with a further, but recoverable, loss of metal of 31 lbs. in the form of shots, skimmings, etc., equal to 0.75 per cent.; this is dependent upon the form and quantity of the moulds, proportions of gates, etc.

TABLE I.—*Analyses of Brass Ingots made from Scrap.*

Constituent.	A	B	B¹	C	C¹	D	D¹	E	E¹	F	G	G¹
Copper	86·36	87·15	86·56	86·75	86·95	87·35	87·15	88·53	85·57	86·56	86·36	87·15
Tin and Antimony	7·88	7·80	8·35	7·72	7·64	7·41	6·54	5·91	7·96	7·88	7·09	7·09
Lead	3·21	3·00	3·21	2·87	2·87	2·59	3·62	2·73	3·89	3·35	3·41	3·14
Zinc	2·33	1·93	1·77	2·49	2·33	2·41	2·49	2·57	2·41	1·93	2·97	2·41
Iron	0·21	0·14	0·14	0·14	0·21	0·21	0·21	0·21	0·14	0·28	0·14	0·21
	99·99	100·02	100·03	99·97	100·00	99·97	100·01	99·95	99·97	100·00	99·97	100·00

Average of six (A, B, C, D, E, and F) Tin, 7·49 per cent.; Antimony, 0·08 per cent.
" " (B¹, C¹, D¹, E¹, G, and G¹) Tin, 6·93 per cent.; Antimony, 0·16 per cent.
Average of the twelve ingots Tin, 7·21 per cent.; Antimony, 0·12 per cent.

Brass-Foundry Shot and Sweepings.

All fettler's dust, moulder's spent sand, furnace ashes and slag, are systematically collected and riddled through a ½-inch riddle to collect coke and clean shot-metal, which is separated. Shot-metal and slag or clinker is sent to the pug mill and crushed wet, the recovered shot-metal being stored separately for disposal, whilst the powdered slag, etc., settles and is collected in a water-tank for subsequent sale. The spent sand containing metal particles is also passed through a riddle to collect the larger shot and afterwards washed in warm water in a hair sieve, thereby collecting every particle of metal, whilst the sand and any oxide dust is likewise washed off and collected for disposal; thus no particle of sand, scale or dust is thrown away by this procedure.

TABLE II.—*Sample Day's Work on Melting in a Tilting Furnace, November* 29, 1910.

Day dry and bright. Fuel used, Durham coke.

No.	Heat. Kind.	Time. Start.	Time. Finish.	Ammeter Reading.	Blast. Inches H_2O.	Details of Charge. Cu.	Pb.	Sn.	Zn.	Ingot Metal.	Scrap.	P.Cu.	Charge. Cwt. qr. lb.	Yield. Cwt. qr lb.	Per Cent. Loss on each Heat.	Coke used. Cwt. qr. lb.	Remarks.
1	Gun metal	6.30	7.30	1·6	2½	352	...	40	8	...	...	...	3 2 8	3 2 3½	1·06	0 2 2 0 2 9	Coke used for starting.
2	Slide valve	8 A.M.	9.15	1·6	2½	160	10	20	...	48	200	10	4 0 0	3 3 24	0·90	0 2 9	Scrap = old slide valves.
3	Injector metal	10.0	11.15	1·6	2½	164	5	20½	10½	250½	...	..	4 0 2½	3 3 27	0·77	0 2 9	
4	Brazing metal	11.30	12.25	1·6	2½	..	...	...	2	(special) 448½	...	...	4 0 2½	3 3 17½	2·88	0 2 9	
5	Copper	1.10	2.15	1·6	3	345	...	...	5	...	...	...	3 0 14	3 0 11	0·85	0 2 9	For tube-hole bushes and plugs.
6	Injector metal	2.45	4.15	1·6	3	164	5	20½	10½	248	...	...	4 0 0	3 3 24	0·90	0 2 9	
	7 hours = 2·8 H.P. hours.												22 2 27	22 1 2½	7·36	4 0 0	= 19·69 lbs. of coke per cwt. of metal melted.

Table II. records a day's run of such a furnace at Horwich. The coke used was of an average Durham quality, having the following composition:—

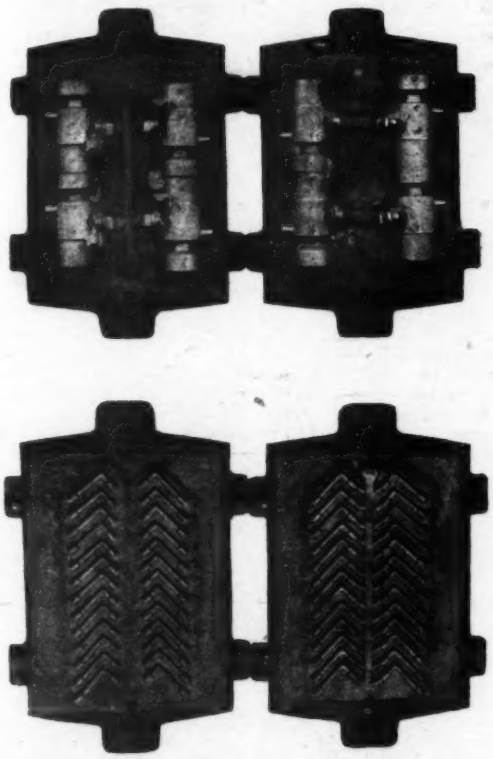
	Per cent.
Carbon	89.24
Sulphur	0.86
Ash	9.35
Moisture	0.55
	100.00

(To be continued.)

Method of Making Match-Plates.*

By Hugh McPhee.

The author has pending a patent for a method of mounting patterns for use on moulding machines or bench moulding which combines cheapness and the elimination of labour in pattern making. This system has been thoroughly tested in the foundry of the Maxwell-Briscoe Motor Company, where it has been in constant use since the foundry was started. In preparing patterns for this Company to be used in moulding machines with which their foundry is equipped, it was noted that many patterns were not adaptable to ordinary match-plate work, because of a



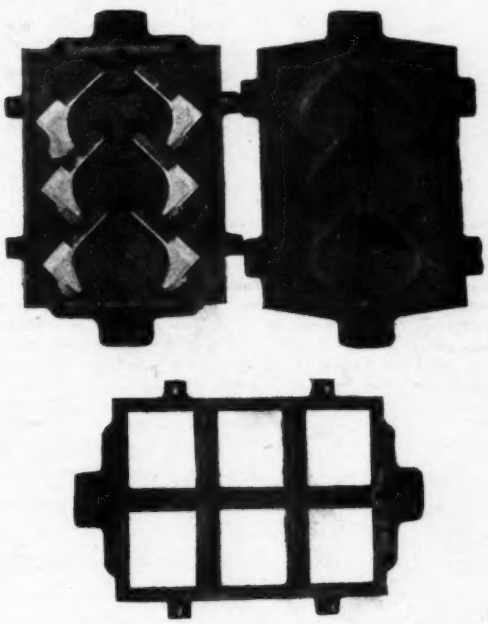
lug, boss, or other projections, being off the centre, thus preventing a straight parting line. This entailed a considerable amount of bench work on the patterns, from which thousands of castings are required, or else the adoption of some way of mounting them other than any which has before been tried.

By the method here described, patterns with an uneven parting line are as easily mounted as are those with a straight parting line, on plates for use in a vibrator machine, or for bench moulding, and at much smaller cost than before possible.

A master pattern of the required casting is first made in wood. From this enough white-metal pattern castings are made to fill the flask. After finishing the white-metal master patterns, the services of the pattern makers are dispensed with, all the rest of the work in making the plate being done in the foundry.

A perfect mould of these patterns, both drag and cope, is rammed up, and after taking the flask apart and drawing the patterns, metal is poured into each impression separately, until it is filled flush with the parting line, a small ladle being used for the purpose. This is done in each half of the mould, which has been left apart since drawing the master patterns.

Iron frames, which take the place of the plates on which patterns are generally mounted for the machine moulding, are then placed on each half of the flask, and



a composition poured into them until they are solid. These frames, a sketch of which is shown, are made to fit the flasks perfectly. The composition with which they are filled is held in place with the bead around the inside of the frame. The cross bars shown act as a reinforcement for the composition, and stiffen the entire plate.

These plates may be used equally as well on the machine, or on the bench, but in either case, the flasks must be perfectly interchangeable in every way, with the pins on the plate. Any foundry contemplating the adoption of this method of using mounted patterns, and having on hand either gated or loose patterns of parts, which they wish to put on plates, can make same from their present patterns. The making of master patterns, previously described, in order to cast the plate is intended only to be used where no pattern whatever exists of the part wanted.

* Presented before the American Brass Founders' Association, Pittsburg Convention.

Foundry Plant and Equipment.

Single-Acting Air Compressor.

The value of compressed air as an auxiliary power in the foundry is now so generally recognised that there are possibly few large concerns in this country which have not a more or less extensive installation. It combines the flexibility of electricity with a variety of application unequalled by any other power. Managers of the smaller foundries, whilst fully alive to the advantages of a compressed-air service, have hitherto been faced with the necessity of a somewhat large capital outlay, and incidentally the installation of a plant with a capacity far above their limited requirements.

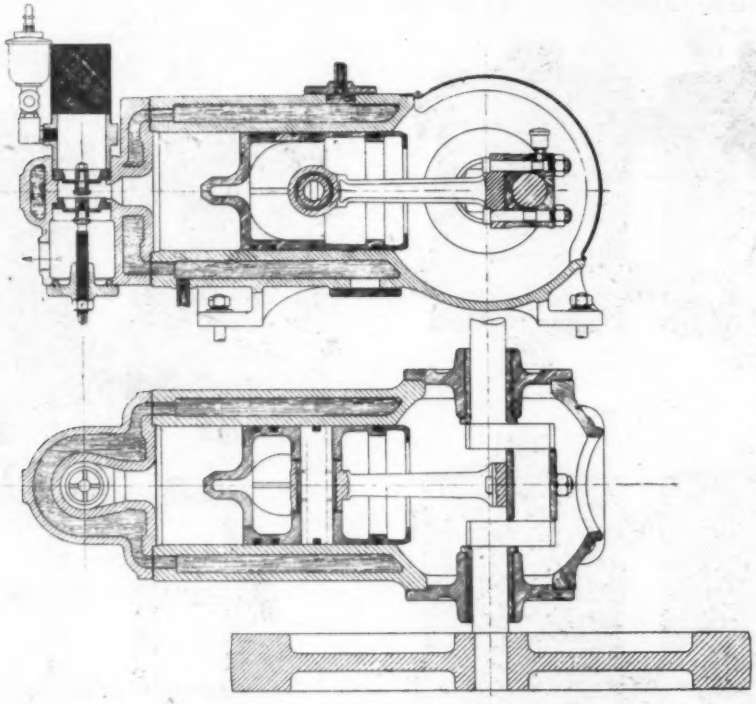


FIG. 1.—PILKINGTON SINGLE-ACTING AIR-COMPRESSOR.

We illustrate herewith a single-acting air compressor, which has been primarily designed to meet the requirements of the small consumer, and of which the initial cost is moderate. The makers are Messrs. Peter Pilkington, Limited, Bamber Bridge, Lancashire. As will be seen from Fig. 1, the feature of the plant is its extreme simplicity, and it calls for little comment. It will be noted that one suction valve and one delivery valve only are used, either of which valves can be taken out and removed without disconnecting any of the pipes. The cylinder and valve-box covers are water-jacketed, and, as will be seen from Fig. 2, a neatly-fitting crank splash-guard is arranged, the whole having a very compact and substantial appearance. The compressors are made in three sizes—10, 20, and 30 cubic feet of free air per min., compressed to 100 lbs. per sq. in. Driving may be either by motor, belt and pulley, or steam, though this last would scarcely be adopted in the foundry, where a belt from the line shaft would be at once the most convenient, economical, and satisfactory drive.

Pneumatic Sand Sifter.

Another auxiliary which our representative saw in operation in the foundry of Messrs. Peter Pilkington, Limited, is the pneumatic sifter illustrated in Fig. 3. This was designed for their own use, but has proved so successful in operation that they have decided to put it upon the market. The feature of the motive power is the entire absence of valves and the fact that there is only one moving part. It is simply a novel application of the "N.S.K." pneumatic hammer. It will work at any pressure from 50 lbs. upwards. It is entirely self-contained, and, of course, extremely portable, whilst the air consumption is merely nominal. The capacity of the sifter illustrated is from 2 to 2½ tons per hour.

An American Disc Grinder for Pattern Makers.

An improved pattern-maker's disc grinder is now being made by the Gardner Machine Company, Beloit,

Wis., U.S.A. The equipment of this machine, which is illustrated herewith, includes a universal work table, universal angle and duplicating gauges, a circular core-print gauge, dust hood, counter-shaft, etc. The grinder is shown with a 30-in. disc wheel on one end and the universal duplicating gauge; while in Fig. 2 is depicted a special pattern recently produced by one of these machines. The following description of the machine is taken from "The Iron Age":—

The universal work table, which may be tilted to any angle with the face of the wheel, is one of the main features of the machine. One turn of the hand

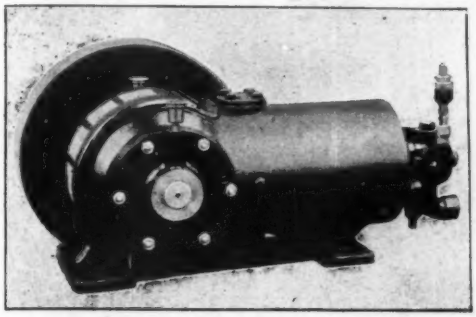


FIG. 2.—PILKINGTON SINGLE-ACTING AIR-COMPRESSOR.

nut locks the table in the required position and the angle is indicated by the graduated segment at the right of the wheel. The design of the axis bearing, or tilting axis, is such that the inside edge of the work remains close to the face of the wheel regardless of its angular or lateral position. The entire weight of the work table is counterbalanced by a weight within the base of the machine. The weight is connected by a steel cable passing over a grooved pulley at the top. This arrangement enables the work table to be raised and lowered easily, and locked at the desired height by turning the hand nut.

FIG. 3.—"N.S.K." PNEUMATIC SAND SIFTER.

The universal duplicating gauge (Fig. 1) is a convenient attachment for producing duplicate work. It is graduated from 0 to 45 degrees in either direction from parallel, and an adjustable stop screw regulates the amount of material removed. One of the special applications of this gauge is in the preparation of segments which can all be got out before the gluing operation is performed. It is also unnecessary to put the pattern on a lathe before attaching additional layers of segments, as they are all parallel and of the same thickness.

The universal angle gauge or protractor head furnished as a part of the grinder's equipment is a great convenience for squaring and producing angles and draught. It is graduated from 0 to 45 degrees in either direction, and by using these graduations in conjunction with those on the head of the table any desired combination of angles can be quickly obtained. The guide bar can be adjusted so that when the table is tilted or the gauge is set at an angle the bar itself can be moved either to the right or the left, thus keeping one end close to the wheel. Like the mechanism of the work table, locking is secured by a single turn of a hand nut, which simultaneously locks the guide bar in the required position and at the proper angle. The circular core-print gauge is employed for producing round or curved surfaces. The work is pivoted on a pin driven in the gauge at the proper radius, and is then swung or turned against the wheel. An adjustable stop screw regulates the amount of material removed, and also makes it possible to produce dupli-

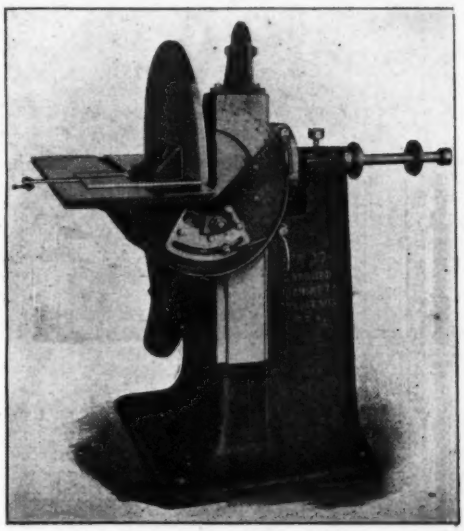


FIG. 1.—PATTERN-MAKER'S GRINDER, BY THE GARDNER MACHINE COMPANY.

cate work, while tilting the table gives the taper required. The use of this attachment enables core prints, bosses, hubs, etc., of all sizes to be made accurately and rapidly.

Time Recorders for Works.

For the accurate recording and checking of workmen's time in factories and works of all descriptions, it is now practically essential to install some automatic apparatus, for the old systems of checking-in at the works gates, etc., allow a good deal of waste time in the course of the year. A number of mechanisms have from time to time been placed on the market for this purpose, but many have failed in practice, owing to intricacy of mechanism and the requirement of frequent repairs. Such systems as have proved successful, however, have been thoroughly appreciated by works managers, and in most of our large engineering establishments time recorders now figure as money savers. In the accompanying illustrations is shown the "S.B. Empire" time-recording equipment with in and out card racks complete. The card racks are designed with the men's numbers at the side, which

are always in view and obviate all mistakes and delays caused by men selecting the wrong card. In works or factories where there are several departments or floors, a recording set is placed in each, in close proximity to the men's work, thus continuously saving time cards, thus providing vouchers for their wages.

As the cards are only taken out of the racks when registering and immediately replaced—the racks may be locked between meals—there is no fear of any being mislaid.

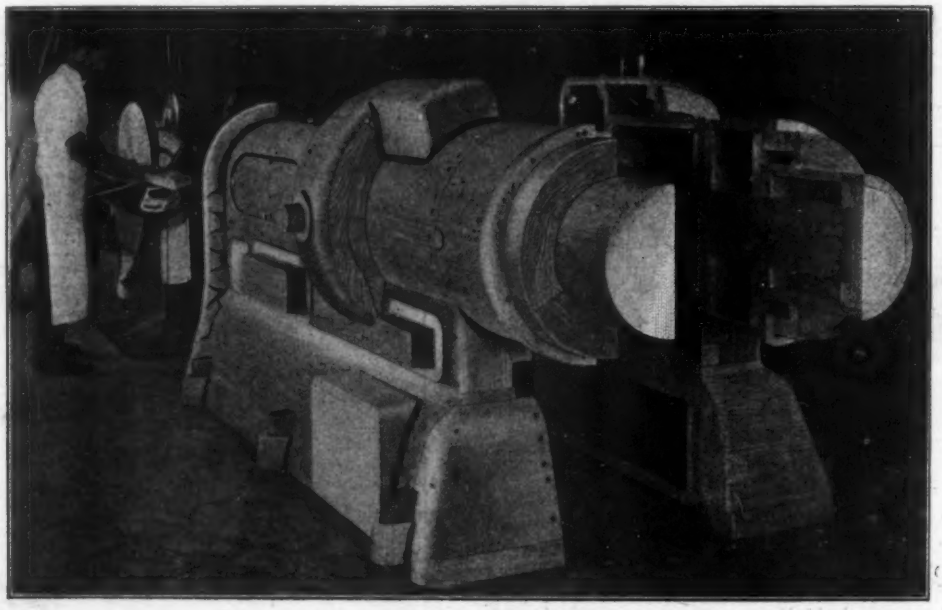
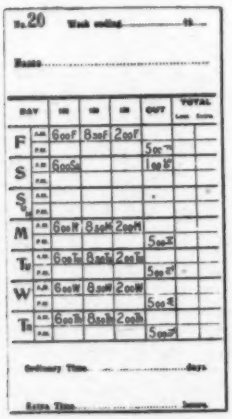
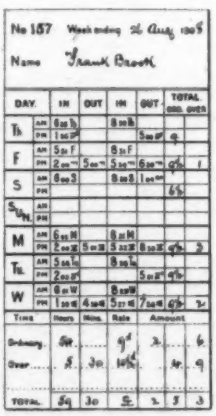


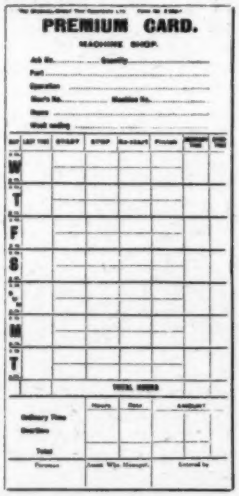
FIG. 2.—SPECIMEN OF WORK TURNED OUT ON PATTERN-MAKER'S GRINDER.

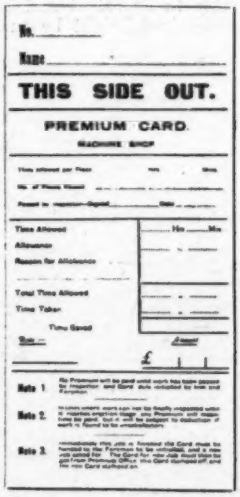
great waste of time as compared with the system of checking their time at the entrance gate. The manager or foreman can see at a glance the employees who are at work and those who are not, by noting the cards in the racks. The card racks can be locked up when not in use.

This system, besides strictly checking the men's time, also provides a means of revising piece rates.









SAMPLES OF TIME-CARDS USED WITH "*S.B.*" RECORDERS.

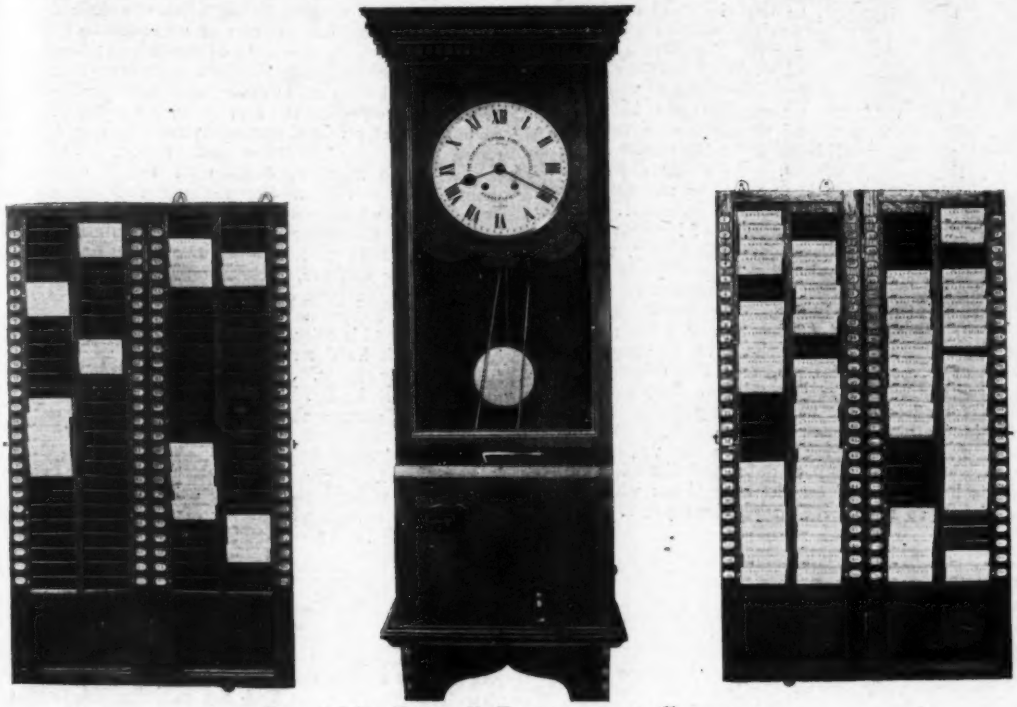
The time clerk may, at any convenient time, check the time cards daily, leaving a minimum of clerical labour for pay day. In the case where it is necessary to make up the "pay" speedily, the time cards can be distributed amongst several clerks for computation, and if necessary the workmen can sign their

Standing charges have to be faced whether the output is much or little, and it is most important to see that piece workers keep good time.

One pattern of the "S.B." machine automatically prints in two colours, punctual times being shown in blue and late times in red.

The "S.B. Empire" apparatus is claimed to be also adapted for accurate "job costing," in addition to time-keeping. It is fitted with an automatic cutting device whereby the time or job card has a small piece cut from its edge at each registration, thus allowing the card to drop to the correct position to receive the next stamping. It will, therefore, be seen that a man working on several jobs per day can stamp his time of starting and finishing each job on one card in correct sequence, or a job card can be designed which shall follow the job from man to man until completed. Any leakage of time between jobs is detected by comparing the totals of the job cards with the totals of the time cards.

The time-recorders just described are made by the Stockall-Brook Time Recorders, Limited, Market Street, Huddersfield.



THE "S.B. EMPIRE" TIME-RECORDING EQUIPMENT.

The Aluminium Industry.

A Paper by W. Kossman, published at Strassburg, on the economic development of the aluminium industry in 1910, gives the following producers of the metal and their individual outputs for 1910:—

Companies.	Production in metric tons in 1910.
Aluminium Industrie Gesellschaft, Neuhausen, etc.	6,000
Société Electro-Metallurgique Francaise, Froges	6,000
Compagnie des Produits Chimiques d'Alais et de la Camarque, Salindres	2,500
British Aluminium Co.	4,000 to 5,000
Aluminium Company of America	12,000
Northern Aluminium Company, Canada	
Société des Forces Motrices et Usines de l'Arve	600
Société des Produits Electro-Chimiques et Metallurgiques des Pyrenees	500
Société Electro-Metallurgique du Sud-Est	300
Société d'Electrochemie	300
Gebruder Giulini, Ludwigshafen	400
Société Italiana per la Fabbricazione dell' Aluminio	600
Anglo-Norwegian Aluminium Company	500

Production and Uses of Zinc Dust.

Zinc dust is obtained in the reduction of spelter by means of special collectors. The quantity of zinc dust recovered in proportion to the production of spelter depends on the furnace charge as well as on the temperature of the distillating furnaces, and may become as high as 10 to 15 per cent. of the spelter produced. To be merchantable it must contain about 90 per cent. of zinc. It is used for various purposes in the industries, *e.g.*, for reducing indigo blue and nitro-benzene, for purifying fats, for bleaching glue, in the Cowper-Coles galvanising process, for the extraction of gold in the cyanide process, and so on. Drewsen's method is recommended for the analysis of zinc dust, which is based on the power of finely-divided zinc to reduce a solution of chromic acid without generating hydrogen.

Alloys for Permanent Magnets.

The addition of chromium to pure iron without carbon does not give good results, according to some authorities. An alloy containing 5 to 6 per cent. of chromium with 0.75 to 1 per cent. of silicon and 0.3 to 0.5 per cent. of carbon is excellent. An alloy containing 8 per cent. of molybdenum, 0.3 per cent. of vanadium, and 0.6 per cent. of carbon makes good permanent magnets, which preserve their magnetic properties above 1,000 degrees C. Alloys of tungsten and iron are useless, except one which contains 4 per cent. of tungsten and 0.4 per cent. of vanadium; this makes an excellent permanent magnet.

"F.T.J." Bookshelf.

Memorandum of New Developments.

Northampton Polytechnic Institute, London, E.C. Session 1911-1912.

We have received from the Institute their annual volume containing particulars of the courses, etc. As regards the equipment, in the electrical engineering department the new generating station opened last winter is now available for the instruction of senior students in both day and evening courses. In the mechanical engineering department the equipment for experimental work in aeronautics has been much increased, and it is hoped that valuable work of a research character will be done by the senior students during the coming winter. In other departments various additions have been made to the equipment, but these do not call for special comment. In the evening classes an important series of lectures is being given jointly by the electrical engineering, technical chemistry and technical optics departments on illuminating engineering. In the mechanical engineering department, to meet the growing development, the course in aeronautical engineering has been divided into two courses, one being the advanced engineering course of previous sessions, and the other a more advanced course for senior students. The new equipment referred to above will form a prominent feature in the laboratory instruction. Throughout there have been a fair number of changes in the various syllabuses, bringing them up to date, and the educational work is being carried on along the lines which have been found so successful in previous years.

Factory Accounts: Their Principles and Practice.

By Emile Garcke and J. M. Fells. Sixth Edition. London: Crosby, Lockwood & Son, Stationers' Hall Court, Ludgate Hill, E.C.

Perhaps one of the most significant tributes to the value of this handbook for accountants and manufacturers is the fact that it has now reached the 6th edition. The changes that have taken place during recent years in methods of production, and the increasing use of machinery, have rendered necessary numerous revisions and extensions of the earlier volumes, but the principles enunciated still apply. With this in mind the authors have taken up the subject thoroughly, dealing separately with each side. Labour, stores, prime cost and the cost ledger, indirect or incidental expenses and their allocation, fixed capital and depreciation, machinery use, and stock—each of these forms the subject of a chapter; while several pages are devoted to surveys and their relation to stocks, accounts, etc. A separate chapter considers subsidiary books, and the final one the various methods of remunerating labour, *i.e.*, timework, piecework, etc. Useful appendices are included on the Income-tax Acts, the rating of factories, fire and boiler insurance, etc., while there are also presented a glossary of terms and a large number of specimen rulings. The work is, undoubtedly, a very useful one for manufacturers in every branch.

Book Review.

Handruch der Eisen-und Stahlgiesserei, Vol. I. Fundamental Principles. Edited by Dr. Ing. C. Geiger. Berlin: Velag von Julius Springer.

In the field of metallurgy, as in so many other of the sciences, Germany has for years been represented by men of first-class attainments, who have from time to time contributed valuable data and information to the annals of research. Since the day of Ledebur, that famous master of metallurgical subjects, there has been a strong band of investigators carrying on his work in the interests of the engineering world, and to-day Germany stands in the front rank in the science. It is not surprising, therefore, to find that this "Handbook of Iron and Steel Founding" is no insignificant publication; in fact, the style of the compilation is worthy of particular note. It has often been acknowledged that any single author is at a disadvantage when writing on the whole of such a subject as foundry work, for he must of necessity be more or less a specialist on one side of the subject, with the result that others get somewhat inadequate treatment. In the book before us, however, this difficulty has been overcome by enlisting the services of a number of men, each apparently versed more particularly in a definite phase of foundry operation and science. This, the first of three volumes, deals with the fundamental principles involved in the melting and casting of metals; and when it is stated that over 460 pages are occupied on that phase of foundry work, it will be appreciated that no cursory survey is presented. No less than ten authors, including well-known names in German metallurgical circles, have contributed articles on different subjects. Prof. Ludwig Beck, Dr. Ing., opens with an historical survey of iron and steel founding, in which he describes the evolution of the craft from its early stages. The economies of iron founding are dealt with by Dr. E. Trescher, and then the editor, Dr. Geiger, gives a short general article on iron and steel. Prof. O. Bauer, Dr. Ing., treats with the metallurgical chemistry of iron, considering in detail the effects of the different constituents, after which Dr. Geiger surveys the characteristics of pig-irons, this chapter covering a variety of irons of German, English, French, American, Swedish, Belgian, Russian and other makes. A chapter on mild steel and other steels by M. Philips, Dr. Ing., is followed by one on the more important of the ferro-alloys, after which Dr. Geiger deals with the handling of scrap materials. The use of briquetted borings in the foundry is a subject in connection with which the name of E. Leber has already come before our readers, and it is not therefore surprising to find the contribution on that matter by that author. The most important qualities of cast irons and their dependence on the chemical composition is dealt with by A. Kessner, who shows clearly the relation between chemical composition, structure, and physical properties. E. Preuss takes as his subject the solidity and mechanical testing of cast irons, detailing the apparatus for the various tests; while W. Venator, a well-known authority on alloys, contributes a chapter treating with the non-ferrous metals and alloys. Georg. Buzek goes well into the question of the combustion of fuels, giving a very interesting scientific chapter; after which Dr. Geiger gives a good practical chapter on the properties of various fuels. The measurement of temperatures in foundry operations is a subject on which Dr. E. Leber writes with familarity, describing a number of pyrometers and other apparatus. A comprehensive chapter, by E. A. Schott, on refractory materials, moulding sands, etc., follows, and the volume closes with a chapter, by M. Philips, on the chemical analysis of the raw and finished materials of the foundry. It will be seen from the foregoing that the groundwork of scientific foundry practice has been well covered; and if the succeeding volumes maintain the same standard, the complete handbook should rank as one of the most valuable foundry reference works ever printed in the German language. In passing, a feature which is worthy of a word of praise is the bibliography appended to each chapter—a valuable guide to existing literature for those who wish to pursue the subjects further.

Inventions.

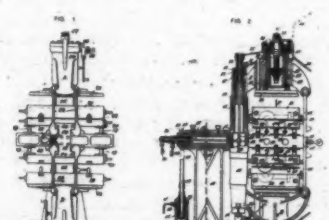
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

19,305. *Electric furnaces. A. L. J. Queneau.
19,381. Metallurgical furnaces. D. Tschernoff and M. Sendzikowski.
19,095. Process for the protection of iron and steel surfaces. S. O. Cowper-Coles.
19,113. Sheet-metal box mouldings. R. & W. Wilson & Sons, Limited, and D. Rose.
20,087. Furnaces. J. E. Fletcher.
20,121. *Process and furnace for melting ferro-manganese and other ferro-alloys. J. I. Bronn.
20,143. Process to render aluminium non-corrosive, ductile, malleable, and tough. S. P. Hutton.
20,144. Reversible regenerative gas furnaces. A. Reynolds.
20,204. Treatment or renovation of foundry sand. A. Poulson.
20,557 *Processes of making castings for steam turbine wheels or the like. W. T. Hopson and C. B. Rearick.

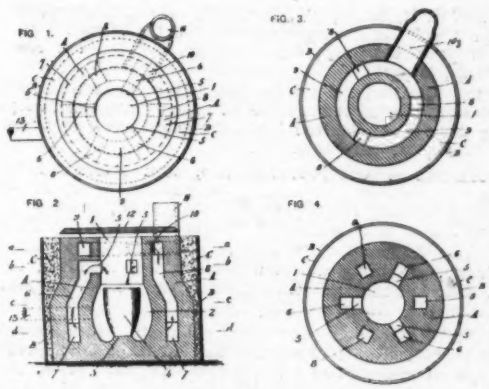
Abstracts of British Patent Specifications recently accepted.

29,068 (1910).—*Foundry Moulding Machines.* Société Anonymé des Etablissements Ph. Bonvillain & E. Roncoray, 9 & 11, Rue des Envierges, Paris, France.—This invention consists in a hydraulic press for moulding, comprising two heads forming cylinders and containing compression pistons, arranged symmetrically at the ends of a hollow column mounted on a horizontal rotary spindle which is supported by a suitable frame, the spindle being adapted to receive a movement of rotation from a hydraulic driving gear. The hollow column is provided in its centre, in the axis of the horizontal spindle, with a moulding table with two faces, to the sides of which are secured respectively the two pattern plates, the compression being effected on the portion of the machine which is above the axis, and the pattern drawing taking place either before or after rotating the machine. By means of this machine it is possible to mould successively two half moulds, the corresponding pattern plates of which are mounted at each side of the horizontal axis can be effected under pressure. Figure 1 is a front elevation of the whole of a moulding press, constructed according to this invention; Figure 2 is a side elevation, partly in section. The moulding press comprises a fixed standard 10, terminating at its upper portion in a socket or sleeve 11, in which with a slight amount of friction the horizontal pivot spindle 12 of the machine can rotate. To one of the ends of the spindle 12 is secured in a perpendicular direction a hollow column 13, comprising two symmetrical cylindrical arms, on each of which a socket or sleeve 15 cast with one of the heads A or B of the machine can freely rotate on ball bearings 14. Each socket 15 is held in the longitudinal direction by a strong collar or ring 16 screwed on the corresponding screw-threaded end of the hollow column 13 and resting on one of the ends of the sleeve 15 on ball bearings 17, as shown in Figure 2. The column 13 secured to a moulding table 18, is arranged in the axis of rotation of the machine, that is to say, in axial alignment with the spindle 12, and at each side of the table is mounted, either directly on the table or by means of braces 19, one of the pattern plates 20, each corresponding to one of the two parts of the mould; the moulding boxes 21 are placed respectively on each of the pattern plates with interposition of or stripping plates 22, if the moulding requires them. The machine is duplicated, and comprises two absolutely identical parts, each corresponding to one of the heads A and B.



Foundry Moulding Machines.

30,287 (1910). *Crucible and Melting-pot Furnaces.* L. F. Tooth, of the Commercial Gas Company, Harford Street, Stepney, London, E.—Fig. 1 is a plan of the furnace with the cover removed; Fig. 2 is a section of the furnace with the cover raised; Fig. 3 is a section of the furnace on the line *a a* of Fig. 2; Fig. 4 is a section of the furnace on the line *b b* of Fig. 2. For the purpose of the invention the furnace A is constructed of firebrick and with a passage or opening 1 from the top part of the furnace leading to an enlarged circular lower part or chamber 2, in the bottom of which is a raised platform 3 on which the crucible or melting pot 4 is positioned. In the passage or opening 1, three or more openings 5, 5, 5, are provided, leading by flueways 6, 6, 6, downwards to an annular flue 7 positioned near and around the bottom of the chamber 2. From this annular ring 7, are three or more other flues 8, 8, 8, these being alternately arranged with the flueways 6, 6, 6, connecting with an annular flueway 9, which is positioned near and around the passage or opening 1 above the openings 5, 5, 5, and is provided with an opening or outlet 10 leading to a chimney 11. The top of the passage or opening 1 is closable by a lid or door 12 properly luted to prevent escape of flame or products of combustion at that part. The furnace A is positioned inside a metal jacket B, the space between being packed with slag wool C or other heat non-conductor to prevent radiation of heat from the furnace. The flame travels around the chamber and the melting pot in a centrifugal manner, and rising will pass into the passage 1 and through the openings 5 down the flueways 6 into the annular flueway 7, and from thence by the flueways 8 into the annular flueway 9 and through the outlet 10 to the chimney 11.



Crucible and Melting-pot Furnace.

Trade Talk.

W. & T. AVERY, LIMITED, have established a branch at 1A, Spring Gardens, Doncaster.

MESSRS. DOWNES & DAVIES engineers' agents, have removed to 1-3, Stanley Street, Liverpool.

MESSRS. PHILIP PIERCE & COMPANY have decided to permanently close their Mill Road Ironworks, Wexford.

MR. J. WHITEHEAD, ironfounder, of Bradford, is paying a first and final dividend of 1s. 11½d. in the £.

THE business of the Leicester Engineering Company, Limited, has been acquired by Livingston & Doughty, Limited.

THOMAS FARRAR, LIMITED, malleable ironfounders, East Parade, Keighley, have changed their title to Walter Slingsby & Company, Limited.

MESSRS. DAWSON & DOWNIE are extending their Eglin Works, Clydebank, Glasgow, by the erection of a new machine shop.

W. T. GLOVER & COMPANY, LIMITED, Trafford Park, Manchester, have removed their Glasgow offices and stores to 158, Hope Street, Glasgow.

AN outbreak of fire occurred in the Possil Engine Works, Glasgow, belonging to Hugh Smith and Company, Limited, recently. Considerable damage was done to the cart sheds and pattern store.

MR. J. B. IMRIE, 217, Buchanan Street, Glasgow, has been appointed sole agent in Scotland for Messrs. Alfred Phillips & Company, chain makers, etc., of the Atlas Works, Tipton.

The EBBW VALE STEEL, IRON AND COAL COMPANY, LIMITED, are, according to local reports, engaged in laying down plant for the manufacture of tubes at Lower Pontnewydd, near Cwmbran.

MAPPLE & GILLOTT, LIMITED, iron merchants, of Sheffield and Birmingham, have purchased the Priorfield Furnaces, Deepfields, Bilston, formerly carried on by H. B. Whitehouse & Son, Limited.

GIBB & HOGG, LIMITED, Victoria Engine Works, Airdrie, are being wound up voluntarily, with Mr. M. R. Mitchell, Morton Villa, Airdrie, and Mr. J. Benson, Marionville, Airdrie, as liquidators.

THE BLAENAVON COMPANY, LIMITED, have made application to the London Stock Exchange to appoint a special settling day in, and grant a quotation to, the recent issue of £250,000 5 per cent. first mortgage debenture stock of the company.

THE application for discharge from bankruptcy of Mr. S. Downs, engineer, boilersmith and iron and brass founder, of South Street, and the Foundry, Hermitage Street, Crewkerne, Somerset, has been suspended for two years.

MESSRS. W. MARSHALL & J. W. MARSHALL, carrying on business as millwrights, general engineers and merchants, at Crown Iron Works, Beaumont Street, Kingston-upon-Hull, under the style of W. Marshall & Company, have dissolved partnership.

GOODWIN, BRUCE & GOVAN, LIMITED, engineers and ironfounders, Blantyre, have appointed Mr. G. Hallett, of the Manufacturers Agency Company, Partridge Road, Cardiff, as their representative in Wales and Monmouthshire.

THE discharge from bankruptcy of T. Garbutt, mechanical engineer, carrying on business at the Reaper Works, Pickering, Yorkshire, has been granted subject to the debtor consenting to judgment being entered against him for £3 and £1 10s. costs.

THE Lincoln, Gainsborough, and Newark Engineering Employers' Association have accepted the resignation of Marshall, Sons & Company, Limited, of Gainsborough. Messrs. Marshall have decided to adhere to their decision to make their boiler shop non-society.

ON Sunday, September 10, a furnace was pulled down at the Grimesthorpe Works of John Brown & Company, Limited, a chimney 200 ft. in height being felled. The furnace was built in 1870, and was demolished to permit of the erection of a new shop.

A PETITION for cessio under the Cessio Acts has been presented to the Sheriff of the Lothians and Peebles at Haddington for cessio of the estates of J. Kirkwood, ironfounder, the Foundry, Tranent, at the debtor's own instance.

MESSRS. W. MASON, S. F. BURNS, and W. A. BLACKBURN, carrying on business as malleable ironfounders, at 8 & 9, Birmingham Street, Walsall, under the style of William Mason & Company, have dissolved partnership.

MR. W. SMITH TAIT, C.A., 79, West Regent Street, Glasgow, the trustee of the sequestrated estates of J. M. Collins, engineer and machinery maker, 121, Swanston Street, Glasgow, intimates that a meeting of the creditors will be held on October 11 to consider his discharge.

THE partnership heretofore subsisting between Messrs. S. C. S. Hickson and E. N. Reade, carrying on business as engineers, at 36, Shaftesbury Avenue, London, under the style of Hickson & Reade, has been dissolved. In future the business will be carried on by Mr. Hickson under the style of Hickson & Company.

IN the matter of the deed of assignment executed on July 5, 1911, by J. Hartley and J. H. Binns, trading as Hartley, Binns & Company, engineers' tool makers, Highroad Well, Halifax, the creditors of the company are required to send in particulars of their claims to Mr. J. D. Simpson, trustee.

CONSIDERABLE damage was done by an outbreak of fire which occurred in the engineering works of Mr. R. G. Abercrombie, Broad Street, Alloa, early on the morning of the 2nd ult. The pattern store and the pattern shop and the fitting and machine shops were gutted.

THE shareholders of the Warrington Steel Foundry, Limited, have decided that the Company cannot, by reason of its liabilities, continue its business, and, accordingly, the Company is to be wound up voluntarily. Mr. Arthur Taylor, of 23, College Hill, London, E.C., has been appointed liquidator.

W. H. DORMAN & COMPANY, LIMITED, engineers, brass- and ironfounders, Foregate Street, Stafford, have acquired land at Lammascotes, near Stafford, for the erection of engineering works. We understand that Mr. W. Haddon, of John Haddon & Company, has lately joined the company.

THE partnership heretofore subsisting between Messrs. E. W. Hodgson, of Millhouses Lane, Millhouses, Sheffield, and T. E. M. Lawson, of Hope, Derbyshire, carrying on business as engineers and iron and steel merchants at 24, Norfolk Row, Sheffield, under the style of E. W. Hodgson & Lawson, has been dissolved.

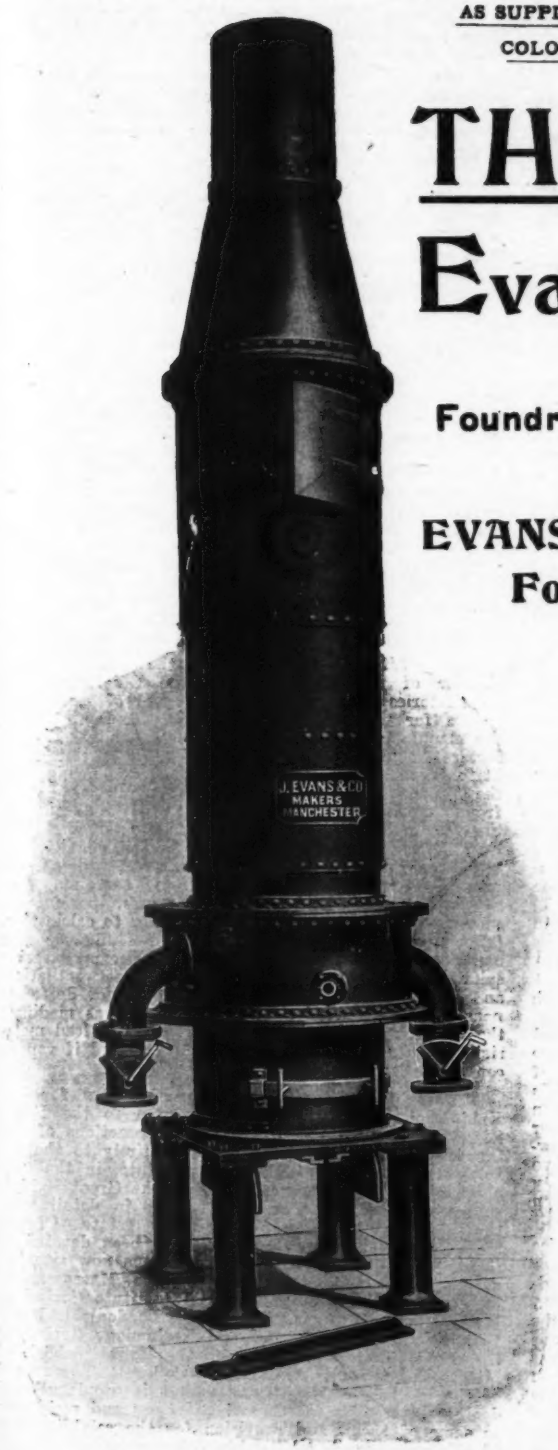
IN the matter of an assignment for the benefit of creditors executed on June 30 last, by T. Platt and F. Platt, carrying on business under the style of T. & F. Platt, at Green Lane Foundry, Birch Street, Walsall, ironfounders and engineers, a first and final dividend is intended to be declared.

MESSRS. H. HORTON and E. W. LANGENBERG, trading as the United Malleable Casting and Engineering Company, at Foundry Lane, Wellington, Salop, have paid a first and final dividend of 2s. 1½d. in the £. In the separate estate of Mr. E. W. Langenberg, a first and final dividend of 2s. 0¾d. in the £ was paid.

CAMMELL, LAIRD & COMPANY, LIMITED, have now taken possession of their new offices in the Royal Liver Building, Liverpool, which are under the direction of Mr. R. M. Laird. The Sheffield business in connection with the products of the Cyclops Works is also being dealt with from these offices.

THE Baku branch of the Imperial Russian Technical Society have now perfected plans for the holding of an international engineering exhibition at Baku (Russia)

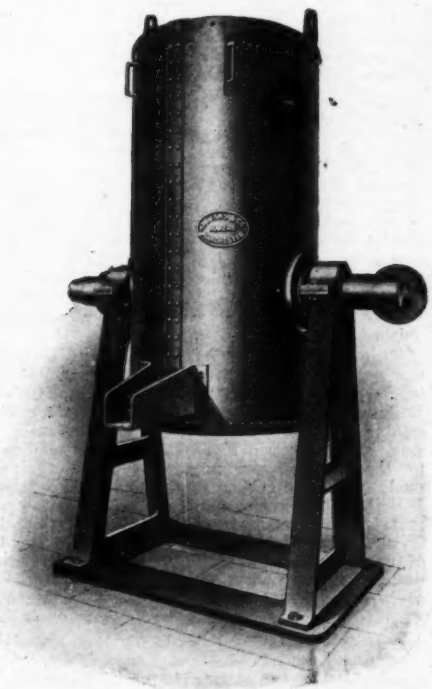
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.



THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

next April. The exhibition will remain open for six weeks. Dr. P. Dvorkovitz, of 1, Broad Street Place, London, E.C., has been appointed the official honorary representative of the exhibition in England.

A NUMBER of the employés of Messrs. Douglas & Grant—principally from the moulding shop—met in a social capacity recently, for the purpose of recognising the long service with this firm of Hugh and William Cunningham—54 years and 52 years respectively. These gentlemen were each presented with a handsome gold albert, suitably inscribed.

THE SHEFFIELD GRATE WORKS, Rotherham, of W. G. Skelton, Corbitt & Company, Limited, were offered for sale at Sheffield on August 29, by order of the receiver for the debenture holders. The works, fixed plant, goodwill, patterns, tools, stock and materials were first offered, the starting price being fixed at £9,500. There was no bid, however. The two principal lots were then offered, but no bids were forthcoming and the whole of the property was withdrawn.

LONDON is to have a permanent exhibition of patents which, it is anticipated by the promoters, will fulfil a long-felt want. The exhibition will be situated in a central position, and will be open to the public all the year round. There will be no charge for admission. The object of the exhibition is to establish a centre where inventors may display their patents for the purpose of attracting the attention of possible purchasers. The offices are at 165, Fleet Street, E.C.

A MEETING of the creditors of W. Challingsworth, carrying on business at the Phœnix Foundry, Heath Street, Birmingham, under the style of Challingsworth & Company, brass and iron founders, was held recently at the office of the Official Receiver (Mr. A. S. Cully), who presided. The liabilities are £2,736, and the assets £135. Debtor attributed his failure to bad trade, keen competition, high price of raw material, and loss on a patent. The matter was left in the hands of the Official Receiver, who stated the assets would, apparently, be more than was anticipated.

UNDER a compulsory winding-up order made last May against J. G. Childs & Company, Limited, engineers, Willesden Green, London, N.W., Mr. H. E. Burgess (Official Receiver) has now issued his report. The accounts show total liabilities £30,202, of which £22,978 is unsecured, the assets, valued at £3,410, being absorbed in debenture claims. The deficiency to the contributories is estimated at £41,060. On March 31 last Mr. H. W. Freshwater was appointed receiver on behalf of the debenture-holders, and is realising the company's assets and completing a number of unfinished contracts.

THE ELECTRO-FLEX STEEL COMPANY, LIMITED, which was registered on May 23 last with a capital of £25,000 in £1 shares, with registered offices at 86, Collingwood Buildings, Collingwood Street, Newcastle-on-Tyne, are establishing works on Tyneside for the manufacture of steel in the electric furnace. The site acquired extends to three acres, and arrangements have already been made with the County of Durham Electrical Power Distribution Company, Limited, for the necessary current. The plant at the outset will consist of two 200 kw. Stassano electric arc furnaces, with a capacity of one ton per charge each, but the works have been designed with a view to future extensions.

IN the Vacation Court, on September 20, Mr. Justice Lush heard a petition by Mr. E. Bieves, a creditor for goods sold and delivered, for the compulsory winding-up of the English McKenna Process Company, Limited. Mr. White, for the petitioner, stated that the company had a capital of £220,000, all of which was paid up. On July 8 last a receiver and manager was appointed on behalf of the debenture holders, and on July 29 he obtained power to sell, which, from the creditors' point of view, made this petition rather urgent. The petitioner had issued a writ for £68 odd for goods sold and had obtained judgment, which had not been satisfied. Mr. Hogg, for the company, said he could not resist the petition, and his Lordship granted a compulsory order, with the usual order as to costs.

NOTICE is given that the names of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved:—A. C. Smith, engineers, Lincoln, Limited; Albany Manufacturing Company, Limited; British Bronze and "Silvo" Metal Company, Limited; Casperds, Limited; Copper Mills Syndicate, Limited; Easton & Bessemer, Limited; Foundries, Limited; Gaines Reversible Propeller Company, Limited; Garter Foundry Company, Limited; Joseph Bullows, Limited; Macbeth & Company (Birmingham), Limited; Philip Howard, Limited; Robert Barker & Company, Limited; Smith & Sons' Wagon Company, Limited; Square Thread Screw Company, Limited; Two-Stroke Engine Company, Limited; Wells Brothers, Limited; and Whale Highway & Wilkes, Limited.

THE Foundry Trade Class at Napiershall School, Glasgow, resumed on the 19th of last month. The instruction in moulding includes the following:—Mensuration; calculating the weight of castings of regular and irregular forms; workshop drawings; drawing of plans, elevations, etc., to full size; moulding sands; the action of gases in same; the behaviour of molten metal in badly ventilated moulds; venting and ramming; shrinkage, contraction, warping, and fracture of castings; greensand, drysand, and loam moulding; the use of air gates and shrinkage heads; types of moulding, open sand, single and double turn-over, two part, three part, cheek and snap flasks; plate moulding, reverse moulding; embossing by claying out; foundry mechanics; machine moulding; mixture of metals for different types of castings in iron and brass. The class is equipped with moulding bench, sand moulding boxes, etc., and the students mould and cast in metal.

WITH further reference to the Home Office circular of February 14, 1911, the Chief Inspector of Factories has now issued a copy of the regulations for the smelting of materials containing lead, the manufacture of red or orange lead, and the manufacture of flaked litharge, made by the Secretary of State on August 12, 1911. The following are the principal points on which the regulations differ from the draft of February, 1911:—(1) Extension of time as regards the exhaust ventilation required by Regs. 2 and 3. (2) Modification of the definition of "lead material" so as to exempt zinc ore, and material resulting from the treatment thereof, containing less than 2 per cent. of lead. Sulphide ores, therefore, it should be noted, are exempted only prior to calcination. (3) A proviso has been added to Reg. 2 allowing lead material to be moved to a furnace by persons wearing suitable respirators when damping, exhaust ventilation, and enclosing, so as to prevent the escape of dust, are none of them practicable. (4) Under Reg. 5 as modified, the use of a covered receptacle in removal of lead material from the exhaust draught is only required if vapour containing lead is given off.

THE eighth report of the Commissioners for the Exhibition of 1851 has been presented to the Home Secretary. Up to the present the transactions of the Commissioners have related almost entirely to the development of the Kensington Gore estate, in the purchase of which the surplus funds of the Great Exhibition were invested. The report deals in detail with the management and resources of the estate. Of the 87 acres originally purchased, 52 have been devoted to public purposes. The list of institutions now situated on the property includes the Science Museum, the Meteorological Office, the Imperial Institute (including headquarters of the University of London), and the Imperial College of Science and Technology (including the Royal College of Science, the Royal School of Mines, and the City and Guilds College). The record of the business of the Commissioners is one largely of dealings over sites for these institutions and assistance to some of them, and provision for the establishment of science research scholarships, for which an annual sum of not less than £5,000 is allotted; but there are also references to future policy which are interesting. The Commissioners now find themselves able to increase the scope of their activities, and they think that the

PURE METALS

and ALLOYS. FREE from CARBON.

TITANIUM THERMIT

for

SOUND, STRONG, CLOSE-GRAINED CASTINGS.

Also FERRO VANADIUM and FERRO TITANIUM.

Full Particulars and PRICES from—

THERMIT LIMITED

Telegrams: "Fulmen, London."
Telephone: 3749 Central,

27, Martins Lane,
Cannon Street, E.C.

Works: 210a, Bow Road, E.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

capital resources of the Commission should no longer be applied to assist in the erection of buildings at South Kensington, but that efforts should be made to give a further impetus to scientific and artistic training consistent with the objects of the charter. They propose, therefore, to provide scholarships and bursaries for limited periods, directed specially to encourage not only research work, but also the training of "captains of industry."

The National Smelting Company, Limited, has recently been formed with a capital of £200,000, which, when in full working order, will be practically the first company of its kind in this country. It has been formed chiefly for acquiring as a going concern the business and assets of Electric Furnace & Smelters, Limited, a company which was incorporated as a private experimental company in 1910, with offices at 110, Cannon Street, London, E.C. It is reported that the experiments made by the Electric Furnace & Smelters, Limited, in the making of ferro-tungsten and other ferro-alloys, were successful, a small factory, with plant capable of turning out about 12 tons of tungsten metal per month, being erected at Luton. Adjoining the factory are the works of the Luton Ironfoundry Company, a business carried on for some years past by Mr. Archibald Finlay Maclaren, the managing director of the Electric Furnace & Smelters, Limited. The benefit of a contract between Mr. Maclaren and the company, whereby the latter acquire an option to take over the land, business and plant of the Luton company, has been transferred to the National Smelting Company. Large quantities of tungsten and other alloys are required by British steel manufacturers, over 900 tons of ferro-tungsten being used yearly in Sheffield alone, while the consumption of other high-priced alloys, such as ferro-vanadium, is at least as great. It is intended that the company shall, at its works in Luton, produce at least 1,000 tons of ferro-tungsten and other ferro-alloys annually. Arrangements have been made whereby the company will be able to obtain a supply of electric power at a very low cost. During the year 1910 an experimental electric furnace was erected at St. Ives, Cornwall, and about 20 tons of tin were smelted there. The result proved the profitable nature of the process. It is proposed that the company shall proceed with the carrying on of this process, which is provisionally protected. Mr. Maclaren becomes the managing director of the company, and Mr. J. Harden will be the technical manager. The board will consist of Mr. A. F. Maclaren, Mr. F. B. Henderson (director of the National Minerals Corporation, Limited), and Earl Russell, chairman of Plenty & Son, Limited, of Newbury.

Personal.

Sir John Jardine, M.P. for Roxburghshire, has intimated that he will not seek re-election.

The late Mr. F. T. Otley, of the American branch of Wm. Jessop & Sons, Limited, left estate of the gross value of £777, with net personalty £577.

Mr. F. Grazebrook, of M. & W. Grazebrook, Netherton Ironworks and Foundries, Netherton, near Dudley, will be the Mayor of Dudley for the ensuing year.

The late Mr. W. H. Herbert, a director of Alfred Herbert, Limited, left estate of the gross value of £195,901, with net personalty £130,431.

The late Sir Frederic Lacy Robinson, K.C.B., a director of Beyer, Peacock & Company, Limited, left estate of the gross value of £8,052, with net personalty £6,329.

The gross value of the estate of the late Mr. D. Ferguson, of Messrs. A. Rodger & Company, St. Helens Engine Works, Govan, Glasgow, is £13,998.

Mr. C. J. Walsh, general manager of Ibbotson Bros. & Company, Limited, of the Globe Steelworks, Alma Street, Sheffield, and Mr. J. H. Chapman, have been elected directors of the company.

The late Mr. R. Henderson, of the Springfield Steel Company, Limited, steel and malleable cast founders, left, in addition to considerable real estate, personal estate in the United Kingdom valued at £38,242.

Mr. A. J. Hobson, of Wm. Jessop & Company, Limited, and Richard Hornsby & Company, Limited, is the prospective Conservative candidate for the Ecclesall division of Sheffield.

The late Mr. J. T. Johnson, ironmaster, of the firm of Messrs. J. T. and W. E. Johnson, West Bromwich, now Johnson's Iron and Steel Company, Limited, left net personalty which has been sworn at £194,951. The gross value of the estate is £195,257.

Mr. D. Galbraith, of the British Westinghouse Electric and Manufacturing Company, Limited, and at one time commercial manager to Hadfields Steel Foundry Company, Limited, has been elected joint managing director of Moses Eadon & Sons, Limited, Sheffield, in conjunction with Mr. J. H. Barker.

The City and Guilds of London Institute has appointed, as members of the Examinations Board of the Department of Technology for a period of three years, Mr. F. Pullinger, Chief Inspector, Technological Branch, Board of Education; Mr. W. R. Davies, Assistant Secretary, Technological Branch, Board of Education; Mr. John Perry, F.R.S., Professor of Mechanics and Mathematics, Imperial College of Science and Technology; and Mr. W. Gannon, Principal of the Woolwich Polytechnic, in place of Mr. C. A. Buckmaster, Professor W. Gowland, F.R.S., Mr. J. H. Reynolds, and Professor W. Ripper, whose terms of office have expired.

New Companies.

Climax Engineering Company, Limited.—Capital £1,000 in £1 shares.

Anchor Iron & Steel Company, Limited.—Capital £10,000 in £1 shares (3,000 five per cent. cumulative preference).

Harding Brothers (Engineers, Westminster), Limited.—Capital £1,000 in 1s. shares. Registered office: 4, Queen Anne's Chambers, Westminster.

Sandix Engineering Company, Limited.—Capital £3,000 in £1 shares. Registered office: 13, Bond Street, Leeds.

Holmes & Pearson, Limited.—Capital £15,000, in £1 shares. Registered office: Royal Iron Works, Goulbourne-street, Keighley.

John H. Clark & Company, Limited.—Capital £12,000 in £1 shares (6,000 preference). Registered office: Broad Lane Ironworks, Fountayne Road, Tottenham, London, N.

Rhodes Cochrane & Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of millwrights, engineers, founders, etc. Registered office: Gorsey Brow, Waterloo Road, Stockport, Cheshire.

Curtis & Company, Limited.—Capital £2,000 in £1 shares (1,000 preference), to carry on the business of engineers, etc. Registered office: 101, Leadenhall Street, E.C.

Fractionate Combustion, Limited.—Capital £2,500 in 1s. shares, to carry on the business of ironfounders, engineers, etc., and to adopt an agreement with A. G. Meeze.

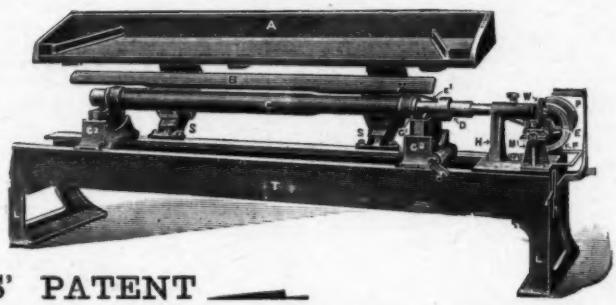
John Jewsbury & Company, Limited.—Capital £6,000 in £1 shares (1,000 preferred), to carry on the business of brassfounders, etc. Registered office: 71, Broad Street, Birmingham.

Schofield & Taylor, Limited.—Capital £12,000 in £1 shares, to take over the business of engineers and millwrights carried on at Perseverance Ironworks, Turnbridge, Huddersfield, as Schofield & Taylor, and to adopt an agreement with F. B. Schofield.

H. A. Harvey & Company, Limited.—Capital £22,000 in 20,000 preference shares of £1 each and 40,000 ordinary shares of 1s. each, to carry on the business of mechanical, civil and marine engineers, founders, etc., to acquire the business and undertaking of H. A. Harvey & Company. Registered office: Norfolk House, Laurence Pountney Hill, E.C.

THE UP-TO-DATE FOUNDRY

CONTAINS



W. JONES' PATENT

GREEN SAND CORE MACHINES.

Many repeat orders received recently from users who have proved its economy.
It forms Cores in Green Sand from 2 ins. to 20 ins. diameter, any length.

Machines in use in ENGLAND, GERMANY, SPAIN, SWEDEN, and INDIA.

JONES & ATTWOOD, STOURBRIDGE.

A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, BOGIES, TRUCKS.
GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and
PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Sept., 1911.	End Sept., 1910.
Iron—Scotch pig warrants ton	*52/3	*54/10½
—Middlesbro' warrants ton	46/1½	48/10½
—W.C. M/nos Bessemer ... ton	64 0	67 6
—Stock, Scotch ... .. tons	1,000	1,000
Copper—Chili bars, GMB ton	£54 15 0	£54 15 0
—Stock, Europe and afloat tons	68,177	93,961
Tin—English ingots ... ton	£185 0 0	£157 10 0
—Straits ... ... ton	£177 10 0	£157 15 0
—Stock, London, Holland, U.S.A., and afloat ...tons		
Lead—English pig ... ton	£15 7 6	£13 0 0
Spelter—Ord. Silesian ... ton	£27 15 0	£23 12 6
Quicksilver (75lb)... bottle	£8 12 6	£8 12 6
Antimony—Regulus . ton	£28 10 0	£28 0 0–£30 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	2 17 6	to	3 0 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 6s. 0d.; all per ton, f.o.b., London. Copper (clean), £50 10s 0d.; brass (clean), £38; lead (usual draft), £14 0s. 0d.; zinc, £22 0s. 0d.; all per ton delivered merchant's yard.

Deaths.

MR. J. FELL, of Thos. Fell & Son, Limited, Hollin Bank Foundry, Blackburn, died recently.

MR. G. H. HASWELL, a director of Tangyes, Limited, died recently.

CAPTAIN ROBERT P. ROY, a prominent official of the Carron Company, and well known in commercial circles, died at Falkirk on August 31 while awaiting a car to convey him to the Carron Works.

THE death was announced in Sheffield on September 4 of Mr. Charles Wardlow, of Messrs. S. & C. Wardlow, Portobello Steelworks, Charlott Street, Sheffield, and Oughtibridge, near Sheffield. He was 75 years of age.

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL and
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, SALFORD.

CAST IN ALUMINIUM AND SAVE MONEY!

A CASTING CONTAINING ONE CUBIC FOOT OF METAL, IN

	Weighs	Costs
ALUMINIUM (Standard B.A. Alloy)	180 lbs.	£5 5 0
Brass	505 ,,	£10 5 0
Gunmetal ...	540 ,,	£14 0 0

THE BRITISH ALUMINIUM Co., LTD.,
Head Office:—
109, Queen Victoria Street, London, E.C.

Trade Mark.

Telegrams: "Cryolite, London."

Telephone: 4315 London Wall.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd., DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

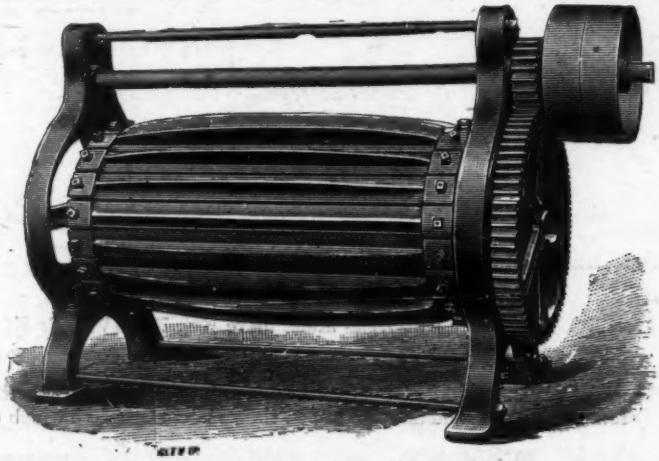
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

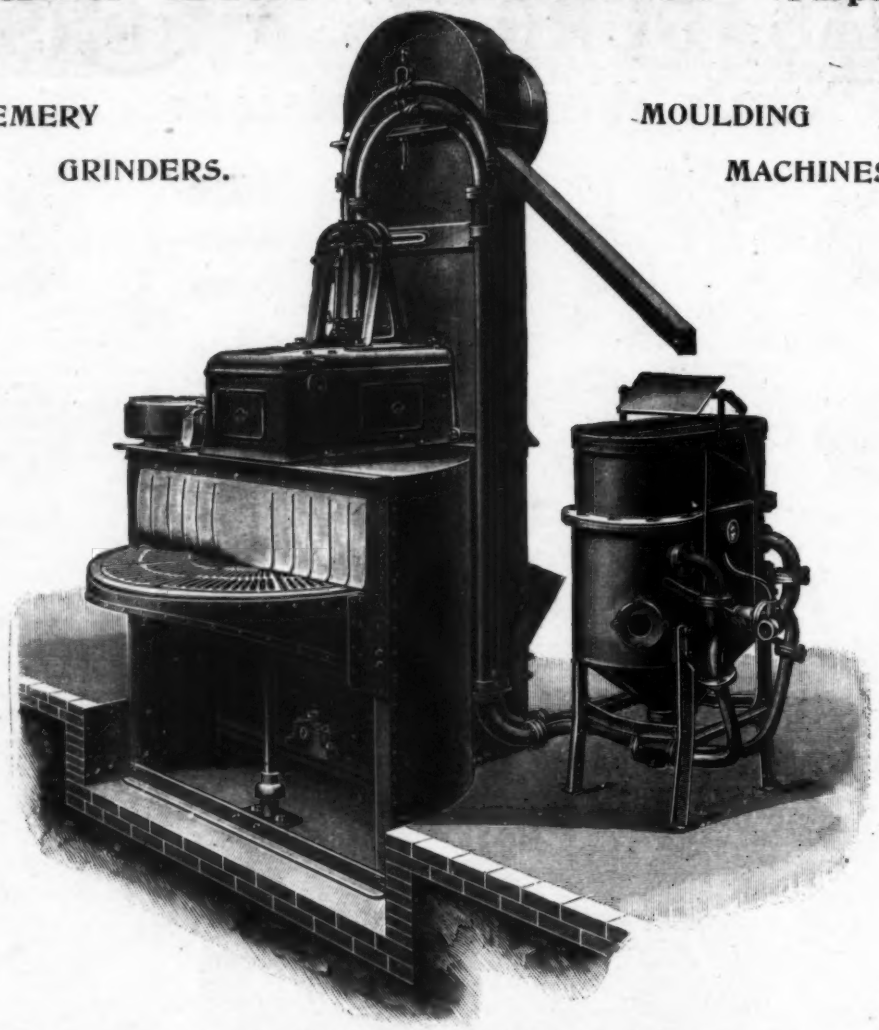
"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

Sand Blast Machines for all Purposes.

EMERY GRINDERS.

MOULDING MACHINES.



Rotary Table Sand Blast Machines for Malleable, Grey Iron, Brass or Gun Metal Castings.

YOUR CASTINGS WILL BE CLEANED much more EFFECTIVELY, ECONOMICALLY and in less time by our SAND BLAST MACHINES than by the old methods of wire-brushing, rumbling or pickling. The sand blast penetrates and scours the crevices of the most intricate castings; abolishes the chipping or breaking of delicate parts, gives an even colour to the surface, and above all thoroughly removes all the sand adhering to it, thus presenting a face which can be machined much more easily.

FULL PARTICULARS AND ILLUSTRATIONS WILL BE POSTED ON APPLICATION.

The London Emery Works Co., PARK WORKS,

TOTTENHAM, LONDON, N.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
Evans, J. & Co.
London Emery Works Co.
Jackman, J. W., & Co., Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Evans, J. & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
F. Braby & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.,Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Keith, James, & Blackman, Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

Blowers—*cont*
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ld.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Silent Machine and Eng. Co.

Chaplets and Studs.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Sykes, James.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.
Williams, John (Birmingham Sand) Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

Core Making Machines.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.
Portway, C. & Son.

Core Ropes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd,
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

Facings.
Evans, J. & Co.
Olsen, William

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Keith, James, & Blackman, Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Evans, J. & Co.
Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

Foundry Blacking.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Firminger, J. & Co., Ltd.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Sykes, James.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.
Williams, John (Birmingham Sand) Ltd.

Foundry Brushes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros Ltd.

THE BUYER'S GUIDE.—*Continued.*

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son
Durrans J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London, Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

Foundry Sand.
Standard Sand Co., Ltd.
Dyson, J. & J.
Evans, J., & Co.
Gould, George
Jackman, J. W., & Co., Ltd
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinning Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Melting Furnaces (Oil fired).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Mould Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Moulding Machines.
Adaptable Moulding Machine Co., The
Britannia Foundry Co.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Pickles, James.
Pneumatic Engineering Appliances Co., Ltd.
Samuelson & Co., Ltd.
Stewart, Duncan & Co., Ltd.
Whittaker, Wm., & Sons, Ltd.

Moulding Machines (Hand and Power).
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Pickles, James.

Pig Breakers.
Evans, J., & Co.
Jackman J. W., & Co., Ltd.
London Emery Works Co.

Pig-Iron.
Bradley & Sons, T. & I., Ltd.
Frodair Iron and Steel Co., Ltd., The
Goldendale Iron Co., Ltd.

Plumbago.
Cumming, Wm. & Co., Ltd.
Durrans, J., & Sons.

Plumbago—*cont.*
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd,
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Pneumatic Tools.
Jackman, J. W., & Co., Ltd.
J. Macdonald & Son, Ltd.
Marshall, H. P. & Co.
Pneumatic Engineering Appliances Co., Ltd.

Polishing Sundries.
Evans J. & Co.
London Emery Works Co.

Publications.
Eagland & Co., Ltd.
Griffin, Charles & Co., Ltd.

Pyrometers.
Alldays & Onions
Phillips, J. W. & C. J.

Recording Gauges.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Riddles.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co., Ltd.

Sand Blast Apparatus.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Sand Driers.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Phillips, J. W. & C. J,

Sand Grinding Mills.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

Sand Mixers.
Evans, J., & Co.
Halls Eng. Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Sand Riddling, Separating and Sifting Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co., Ltd.
Pneumatic Engineering Appliances Co., Ltd.

Sieves.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Smiths' Hearths.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., H. P., Ltd.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.

Steel Moulders' Composition.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Lowood, J. Grayson, & Co., Ltd

Spades and Shovels.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Stone Flux.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.

Stoppers and Nozzles.
Dyson, J. & J.

Straw Ropes.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, William.
Wilkinson & Co., Thos., Ltd.

Testing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.

Time Recorder.
National Time Recorder Co.
"Stockall-Brook" Time Recorders Co.

Tuyeres (Firebrick).
Dyson, J. & J. [Ltd
Lowood, J. Grayson, & Co.

Welding. Thermit, Ltd.

FOR
IRONFOUNDERS' BLACKING, COAL DUST, ETC.
Registered "SHALAGO" Brand.
Write for Quotations to—
WILLIAM CUMMING & Co., LTD.,
IRONFOUNDERS' FURNISHERS.
WORKS— { Kelvinvale Mills, Maryhill, Glasgow.
Whittington Blacking Mills, Chesterfield, Eng
Sunnyside Blacking Mills, Falkirk, N.B
also at Middlesbrough and Albion, West Bromwich.
TELEGRAPHIC ADDRESSES— { "Prudence, Glasgow."
"Cumming, Whittington, Chesterfield.
"Cumming, Blacking Mills, Lamelon."

SITUATIONS VACANT AND WANTED.

STOCKHOLM, SWEDEN.—Swedish Agents (Manager will shortly arrive in England) want the REPRESENTATION of a First-class English Firm.—Reply to "AGENCY," Gumaelii Annonsbyra, Malmo, Sweden.

FOREMAN MOULDER desires change. Smart in Electrical, Constructional, and General Engineering. Expert Metal Mixer. Good organiser. First-class references.—Address Box 526, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOUNDRY MANAGER or FOREMAN PATTERN-MAKER desires change. Qualified in every class of General and Motor Work, with exceptional knowledge of Foundry modern practice and methods. Used to control of men. Reliable time-keeper.—References in application to Box 528, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

PATENT.

THE Proprietors of Patent No. 16,956/08, relating to "Improvements in the Process of and Apparatus for the Manufacture of Cast Metal Wheels," invite communications with a view to the sale of the Patent or to the granting of Licenses to work the Invention in Great Britain on reasonable terms. An illustrated description of the Invention will be forwarded on application.—Address Brewer & Son, 33, Chancery Lane, London, W.C.

FOR SALE AND WANTED.

BOOKS on ENGINEERING, TECHNICAL, SCIENTIFIC, LITERARY, and all other subjects. Second-hand at Half-prices. New at 25 per cent. discount. Catalogue No. 433, free. State wants. Books sent on approval. Books bought. Best prices given. W. & G. FOYLE, 135, Charing Cross Road, London, W.C.

WANTED, for Cash, Brass and Gun-metal Scrap Turnings, Condenser, and Loco. Tubes, Brass Dust, Mixed Metals, etc.—RAPID MAGNETTING MACHINE COMPANY, LTD., Crescent, Birmingham.

PATTERN-MAKING.—All kinds of PATTERNS, large or small, made to customers' designs, by experienced workmen; accuracy and prompt delivery guaranteed.—LAMBERT BROS., Engineers, Snodland.

NAISH & CROFT,
Consulting Metallurgists & Analytical Chemists.
—— SPECIALISTS IN FOUNDRY WORK. ——
Laboratory for investigations of all kinds.
TRANSVERSE, TENSILE AND CRUSHING TESTS.
MICROGRAPHS.
Scale of Fees on application. *Correspondence invited.*
Special Terms for Contract work.
Address 141, WHITEHEAD RD., ASTON MANOR, BIRMINGHAM.

FRODAIR SPECIAL PIG-IRONS

ENJOY 25 YEARS' REPUTATION FOR THE BEST RESULTS.

THEY ENSURE REGULARITY AND GREATER DURABILITY IN SPECIAL CASTINGS. EASILY MELTED, CAST AND TOOLED.

FRODAIR

FOR CYLINDERS OF ALL KINDS, ROLLS (Chilled and Grain), VALVES, LINERS, PISTON RINGS, HIGH-PRESSURE CASTINGS, FIRE AND ACID-RESISTING CASTINGS, &c.

USED BY THE MOST IMPORTANT AND UP-TO-DATE FOUNDRIES.

Write for details of tests, &c., to—

THE FRODAIR IRON & STEEL Co., LTD., FENCHURCH HOUSE, LONDON, E.C.

Telegrams: "Frodair, London."

COMPLETE SAND BLAST APPARATUS

For Cleaning large and small Castings.

WILL SAVE 50 PER CENT. IN FETTLERS' WAGES.

IN USE BY THE FOLLOWING WELL-KNOWN FIRMS:—

STEEL CASTINGS.

Beardmore, W., and Co., Ltd.	Glasgow.
Steel Co. of Scotland	Glasgow.
Coltness Iron Co.	Coltness.
Dickson and Manns, Ltd.	Armadale.
Vickers, Sons and Maxim, Ltd.	Barrow.
Darlington Forge Co., Ltd.	Darlington.
Shaw, W., and Co.	Middlesbrough.
Hadfields' Steel Foundry Co., Ltd.	Sheffield.
Osborn, S., and Co., Ltd.	Sheffield.
Jackson, P. R., and Co., Ltd.	Manchester.

MALLEABLE IRON.

Ley's Malleable Castings Co., Ltd.	Derby.
Crowley, John, and Co., Ltd.	Sheffield.
Baker Foundry Co., Ltd.	Smethwick.
Maddocks, J., and Co., Ltd.	Oakengates.
Clegg and Howgate, Ltd.	Keighley.
Croft Foundry Co., Ltd.	Walsall.
Lindop, H. W.	Walsall.
Tangyes Ltd.	Birmingham.
Harper, J., and Co.	Willenhall.
Haden, G. N., and Sons	Trowbridge.

ORDINARY IRON CASTINGS.

Platt Bros. and Co., Ltd.	Oldham.
Tweedales and Smalley	Castleton.
H.M. Dockyards	—
Dobson and Barlow, Ltd.	Bolton.
Doulton and Co., Ltd.	Paisley.
Ruston, Proctor and Co., Ltd.	Lincoln.
Marshall, Sons and Co., Ltd.	Gainsborough.
Shanks and Co., Ltd.	Barrhead.
Falkirk Iron Co.	Falkirk.
Hopkinson and Co.	Huddersfield.

BRASS OR GUN METAL.

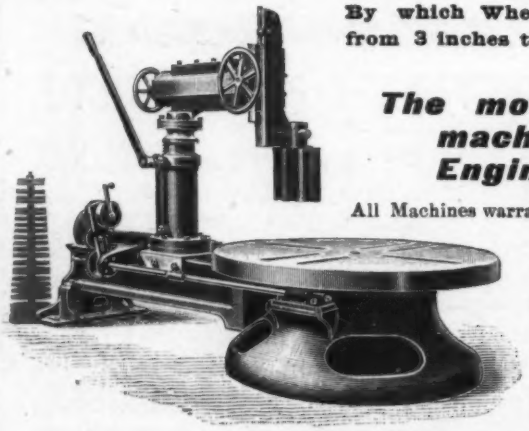
Vickers, Sons and Maxim, Ltd.	Barrow.
Gummer and Co.	Rotherham.
Ruston, Proctor and Co., Ltd.	Lincoln.
Storey, Isaac and Sons, Ltd.	Manchester.
Glenfield and Kennedy	Kilmarnock.
Milne, J., and Son	Edinburgh.
Benton and Stone	Birmingham.
British Insulated and Helsby Cables, Ltd.	—
Marshall, Sons and Co., Ltd.	Gainsborough.
Dewrance and Co.	London.

General Representative: GEO. HOPKINS, 63, Quarrenden Street, King's Road, Fulham, London, S.W.

TILGHMAN'S PATENT SAND BLAST Co., Ltd.,

BROADHEATH, Nr. MANCHESTER.

WHITTAKER'S IMPROVED MOULDING MACHINE



By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE. NO	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS.	TELEPHONE NO
630	Alldays & Onions, Ltd....	Birmingham	Alldays, Birmingham	28 Victoria
630	Braby, F., & Co., Ltd.	Petershill Road, Glasgow...	Braby, Glasgow	—
628	Bradley, T. & I., & Sons, Ltd.	Darlaston	Bradley, Darlaston	—
626	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
678	British Aluminium Co., Ltd.	109, Queen Victoria Street, S.E. ...	Cryolite, London	4315 London Wall
682	Cumming, William, & Co., Ltd.	Maryhill, Glasgow	Prudence, Glasgow	P.O. M. 25
C ii.	Dempster, R. & J., Ltd.	Oldham Road, Manchester	Scrubber, Manchester	—
633	Davies, T., & Sons	West Gorton, Manchester...	Tuyere, Manchester	70 Openshaw
679	Durrans, Jas., & Sons	Penistone, nr. Sheffield	Durrans, Penistone	—
C. ii.	Dyson, J. & J.	Sheffield	Dyson's, Stannington...	702 Sheffield
677	Elders' Collieries Ltd.	Cardiff	Elder, Maesteg	10
632,675	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
626	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
683	Frodair Iron & Steel Co., Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
629	Fyfe, J. R. & Co.	Shipley, Yorks	Brick, Shipley	59 Shipley
629	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs ...	—
	Gould, George	Old Canal Wharf, Stourbridge... ...	—	—
	Hall, Charles & Co.	Dantzic Street, Manchester	—	5814 City
628	Harris & Pearson...	Stourbridge	Fireclay, Stourbridge	7 Brierley Hill
626	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
624	Hodges, R. I., & Co.	14, Devonshire Sq., Bishopsgate, E.C.	—	—
C. iv.	Jackman, J. W., & Co.	Caxton House, S.W.	Molders, London	30 Victoria
629	Keith, James, & Blackman, Co., Ltd...	27, Farringdon Avenue, London ...	James Keith, London	6194 H'lb'rn(4 lines
628	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
*680	London Emery Works Co., Ltd.	Park, Tottenham	Naxium, London	99 Tottenham
678	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
627	Macdonald, J. & Son, Ltd.	Maryhill, Glasgow	Compressor, Glasgow	161 Mary Hill
	Manserghi, T. E.	Wheathill Charcoal Works, Salford	—	—
673	Marshall, H. P., & Co.	Leeds	Specialty, Leeds	909 Leeds
625	Metalline Cement Co.	112, Bath Street, Glasgow...	Adhesive, Glasgow	201Y2 Douglas
625	Mitchell's Emery Wheel Co.	Bradford, Manchester	Diameter, Manchester	Central, 3575
624	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
683	Naish & Croft	5, Blackfriars Road, E.C.	Natrecord, London	918 Hop
624	National Time Recorder Co.	141, Whitehead Road, Aston Manor	—	—
622	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	599 Y.I.
	PhillipsChas, D.	Newport, Monmouthshire	Machinery, Newport	18 & P.O. 576
622	Phillips J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central.
C. iii.	Plasti-Kion Co., The	Caxton House, S.W.	—	—
629	Portway, C. & Son	Halstead, Essex	Portway, Halstead, Essex	10 P.O. Halstead
C. iii.	Robeson Process Co.	17, Fenchurch Street, E.C.	Sprudel, London	6045 Bank
	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	—
628	Silent Machine Co.	Albion Works, Sallie St., Sheffield.	Forward, Sheffield	—
621	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield...	201 Mansfield
627	Stewart, D., & Co. (1902) Ltd.	London Road Ironworks, Glasgow...	Stewart, Glasgow	71 P.O.Bridgt'n & 3243 Bridgton(N)
622	Stockall Brook Time Recorders, Ltd. ...	43, Market Street, Huddersfield ...	—	1069 Huddersfield
677	Thermit, Ltd.	27, Martin's Lane, E.C.	Fulmen, London	3719 Central
684	Tilghman's Patent Sand Blast Co., Ltd. ...	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
631	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	325 Bradford
626	Walker, I. & I.	Rotherham	—	—
684	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers, Engineers, Oldham	83
625	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking, Middlesbro.	419
622	Williams, J. (B'ham Sand) Ltd.	Birmingham	—	—

MANSFIELD MOULDING SAND.

As Shipped by us to all parts of the World,
for Castings of Iron, Brass, Aluminium, &c.

WRITE STATING CLASS OF WORK TO

The Standard Sand Co., Ltd.,
Mansfield, NOTTS.

PLUMBAGO,
Foundry Blacking,
Terra Flake,'
NEW CORE GUM,
CRUCIBLES.

. . CARRIAGE PAID QUOTATIONS. . .

WM. OLSEN, COGAN STREET, HULL.

FOUNDRY SANDS
OF ALL GRADES.

Owners of noted Birmingham Moulding Sand Quarries—

JOHN WILLIAMS (BIRMINGHAM SAND) LTD.
BIRMINGHAM.

S.B. Empire Time Recorders.
Are BRITISH MADE throughout.

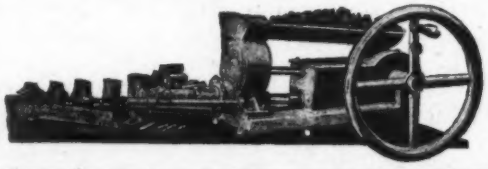
ONE MACHINE REGISTERS

ANY NUMBER OF EMPLOYEES
ANY NUMBER OF TIMES
DAY AND NIGHT SHIFT SEPARATELY
REGULAR AND OVERTIME SEPARATELY
EACH DEPARTMENT SEPARATELY
GIVES WEEKLY OR FORTNIGHTLY TABULATED CARD.

WRITE FOR OUR NEW DESCRIPTIVE BOOKLET ON TIME AND JOB COSTING.

The Stockall Brook Time Recorders, Ltd.,
43, Market Street,
Huddersfield.

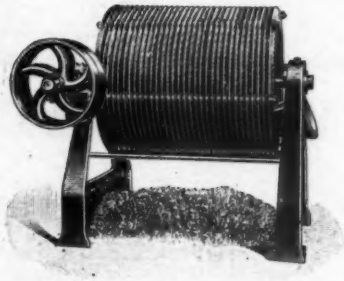
THE SWEDISH PATENT
"PERFECT" CORE MACHINE



supersedes all the machines with screws, which wear out, It works with a plunger, and is built to last. No oil or binder is required. Some hundreds giving satisfaction in Sweden, Norway, England, Germany, Russia, &c.

THE LATEST & BEST
SAND SIFTER & MIXER
OUTPUT 2 TONS PER HOUR.

MAYER-PHILLIPS PATENT. 1911.



This machine is replacing other types owing to its simple, strong and practical design. Constant supply of sand, no attention, little power. All kinds of sand can be treated.

J. W. & C. J. PHILLIPS, LTD., 23, College Hill, Cannon Street, LONDON, E.C.

T. DAVIES & SON,

RAILWAY WORKS, WEST GORTON, MANCHESTER.

ON ADMIRALTY LIST.

Telegrams—"TUYERE, MANCHESTER. Nat. Telephone—No. 70, OPENSHAW.

Specialities.

FOUNDRY CUPOLAS & LADLES

ALL TYPES AND SIZES IN STOCK OR PROGRESS.

LICENSEES and MAKERS of

Osborn's Patent Spark Arrester

FOR FOUNDRY CUPOLAS.

Efficient. Simple in Design.

Require no Attention.

Prevent Fire or Damage to Surrounding Buildings.

SAVE THE COST OF FREQUENT CLEANING OF THE ROOFS AND GUTTERS.

THOROUGHLY RELIABLE.

HODGES PATENT TURBINE BLOWERS.

40% Less Power to Drive than any other Blower.

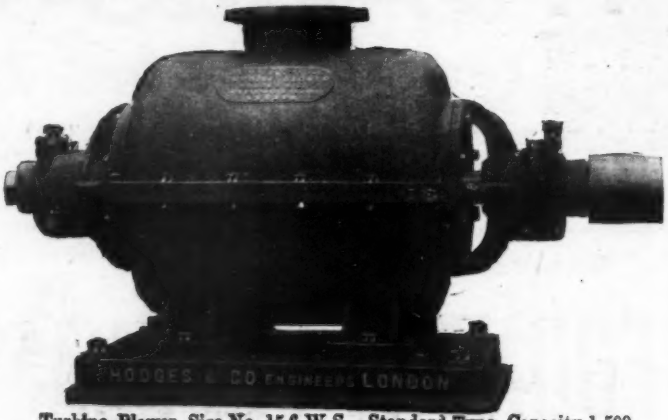
No Internal Friction.

No Noise.

No Wear and Tear.

Perfectly Steady.
Blast Pressure.

Direct—Coupled to Electro-Motor, Steam Turbine, Petrol Engine or with Pulley for Belt Driving.



Turbine Blower, Size No. 15-6 W.S. Standard Type, Capacity 1,500 to 2,000 cub. ft. per minute.

Made in 8 Standard Sizes, Capacities 50 to 15,000 Cubic feet per min.
VARYING PRESSURES UP TO **20 lbs.** PER SQUARE INCH.
For BLAST FURNACES, STEEL CONVERTERS, CUPOLAS, SMITH'S HEARTHS and OTHER PURPOSES
HIGHEST CLASS BRITISH MATERIAL AND WORKMANSHIP.

***R. J. HODGES & CO.,* ENGINEERS, 14, DEVONSHIRE SQUARE, BISHOPSGATE, LONDON, E C.**

38½"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES.
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical or metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
36"
32½"

THE TIME RECORDER

For FOUNDRIES, POWER STATIONS, CONSTRUCTION ENGINEERS, AND REPAIR WORKS IS THE

NATIONAL.

They register any number of employees and render a full weekly or fortnightly tabulated record of each employee's time of arrival and departure.

Write for particulars to

THE NATIONAL TIME RECORDER CO.,

Patentees and Manufacturers,

5, Blackfriars Road,
LONDON, S.E.

Telephone 918 Hop.
Telegraph Address:
"NATRECORD, LONDON."

Scrap Heap Reduced to a Minimum.

METALLINE CEMENT COMPOUNDS.

REGISTERED

TRADE MARK.

INDISPENSABLE IN THE FOUNDRIES AND ENGINEERING WORKSHOPS NOW RECOGNISED TO BE THE **MOST RELIABLE IRON COMPOUNDS** THAT CAN BE PROCURED.

VALUABLE for treating defective Castings, making permanent repairs to Engines, Boilers, Tanks, etc., etc.

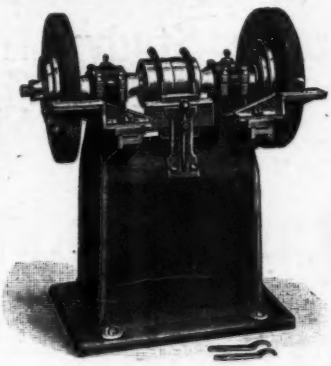
WRITE FOR **FREE** TRIAL **SAMPLES, PRICE LIST** AND **INSTRUCTION BOOK.**

Sole Proprietors and Manufacturers: **THE METALLINE CEMENT CO.,** Head Office: 112, BATH STREET, **GLASGOW.**

HIGH-CLASS

GRINDING WHEELS

FOR ALL WORK.



UP-TO-DATE

GRINDING MACHINES

OF ALL TYPES.

MITCHELL'S EMERY WHEEL CO.,

Castle Works, Bradford, MANCHESTER.

: : SEND FOR NEW ILLUSTRATED LIST. : :

TELEPHONE: 3575 CENTRAL. . . . TELEGRAMS: DIAMETER, MANCHESTER.

It will Pay You to Use the Best

COAL DUST

None is quite so good as that made from Best Durham Coal. We grind and screen it into several different sizes to suit different kinds of work, and can put it on Rails or Ship it at Middlesbrough, Stockton or West Hartlepool at a very low price.

We actually send it to distant Coal producing districts where the carriage costs more than the Coal Dust. This demand proves its excellence! Why not try it?

Agents for "Glutrin" Sand Binder.

THOMAS WILKINSON & Co., LTD., Foundry Stores, MIDDLESBROUGH.

The use of Moulding Machines is Limited

by the knowledge of those responsible for them. An expert can make almost any casting on a Moulding Machine much better, quicker, and at less than half the price the same article can be made by hand.

Commence this **Profitable Study** and write for Booklet on the "Coventry" Patent Moulding Machines to the makers.

THE BRITANNIA FOUNDRY COY.,

Cox Street, **COVENTRY**, Eng.

FERRO-VANADIUM. * * * **FERRO-TITANIUM.**

SILICO-MANGANESE {23/30 % Silicon, 65/70 % Manganese & 1 %, 2 %, 3 %, Carbon Maximum.

FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.

FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.

ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*

WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.

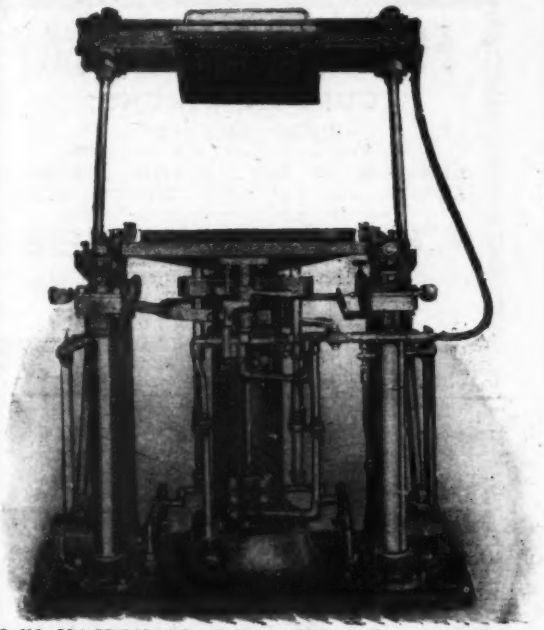
EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.

Telegrams: "PERSISTENT." Telephone No. 1134 (3 lines).

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES,
. . . ANNEALING OVENS, FURNACES, &c. . . .

R. & G. HISLOP,

Gas Engineers, Underwood House, PAISLEY.



JOHN MACDONALD & Son, Ltd., Moor Buildings, Pilgrim Street, Newcastle-on-Tyne.
JOHN MACDONALD & Son, Ltd., Norwich Union Chambers, Birmingham.
JAMES R. KELLY & Co., Bridge End, Leeds Bridge, Leeds.

Telegrams:—"Compressor, Glasgow."
Telephones:—National, 61 Maryhill, Post Office, 69 Kelvin.

John Macdonald

—— & SON, Limited. ——

Pneumatic Engineers,

WATT ST., MARYHILL, GLASGOW

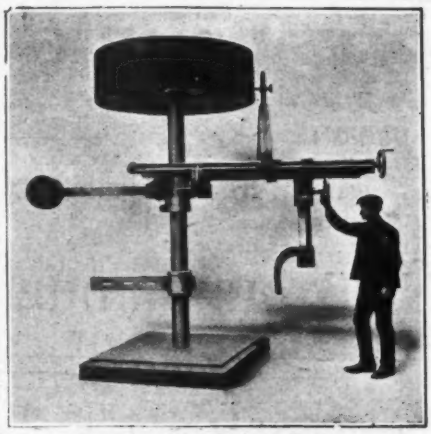
"Ajax" Pneumatic Combined Jolting and Power Press Moulding Machine.

The Machine that is suitable for deep and shallow work.

The Machine that will make a complete mould in a few seconds without any hand work, forms the sand hardest about the pattern.

Inquiries and Correspondence Invited.

British Made Pneumatic Appliances for the Foundry.



Standard Wheel Moulding Machine.

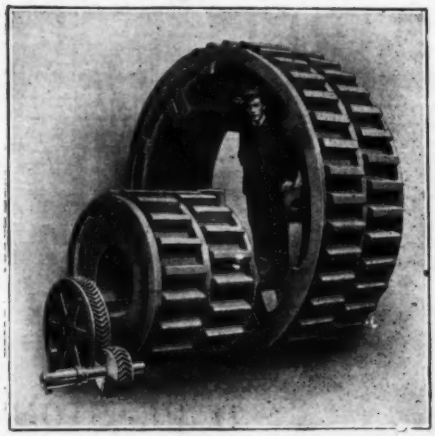
ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

* *



Wheels Moulded by this Machine.

No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.

LONDON ROAD IRONWORKS, GLASGOW.

S.M.S

WHAT IS IT?

SWIFT — METALLIC — STOPPING

The British Foundry Cement.

FOR FILLING UP BLOW HOLES IN CASTINGS . . . . . IT DRIES IN ONE HOUR, AND IT CAN BE FILED UP IN FROM SIX TO TWELVE HOURS . . . .

SAMPLE FREE — TRIAL TIN 1/-

AGENTS WANTED.

THE SILENT MACHINE COMPANY,

SAVILE STREET, SHEFFIELD.

FIRE BRICKS & CLAY

CUPOLA BRICKS.

BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,

(STOURBRIDGE) Ltd.,

STOURBRIDGE.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS,

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD, CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.

STOURBRIDGE FIRE BRICKS

Of Best Quality for Lining Cupolas in Stock,

ALSO MADE TO ANY DESIGN.

Linings Stocked to Customers' Plans to ensure IMMEDIATE DELIVERY.

All kinds of Fireclay Goods of Highest Quality.

HARRIS & PEARSON, STOURBRIDGE.

Telegrams:—"FIRECLAY, STOURBRIDGE." Telephone:—No. 7 Brierley Hill.

T. & I. BRADLEY & SONS, LTD.,

COLD BLAST PIG IRON

PIG IRON BRANDS

PART MINE. WARM AND COLD BLAST. I X L. ALL MINE. A M

TO GUARANTEED ANALYSIS.

DARLASTON BLAST FURNACES,

DARLASTON, SOUTH STAFFS.

THE KEITH LIGHT.

60 CANDLES PER CUBIC FOOT.

THE MOST ECONOMICAL SYSTEM ON THE MARKET.

UNSURPASSED FOR FOUNDRY AND WORKSHOP LIGHTING.

OVER 7,000 INSTALLATIONS IN USE.

James Keith & Blackman Co., Ltd.,
27, Farringdon Avenue, LONDON.

CUPOLA BRICKS

FOR LINING ORDINARY AND PATENT

CUPOLA FURNACES.

JOHN R. FYFE & Co.,
SHIPLEY, Yorks.

GEORGE GOULD,

OLD CANAL WHARF,
STOURBRIDGE.

FOUNDRY SAND

(MINE OWNER).

IRON AND COAL MERCHANT.

PROMPT DELIVERIES BY TRUCK OR BOAT.

THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use, and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it.

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director

Makers: **C. PORTWAY & SON,** TORTOISE STOVE & PORTWAY PORTABLE OVEN WORKS, **HALSTEAD, ESSEX.**

A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour** and can be emptied **much more quickly.** It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "R.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS. BOGIES, TRUCKS.
GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

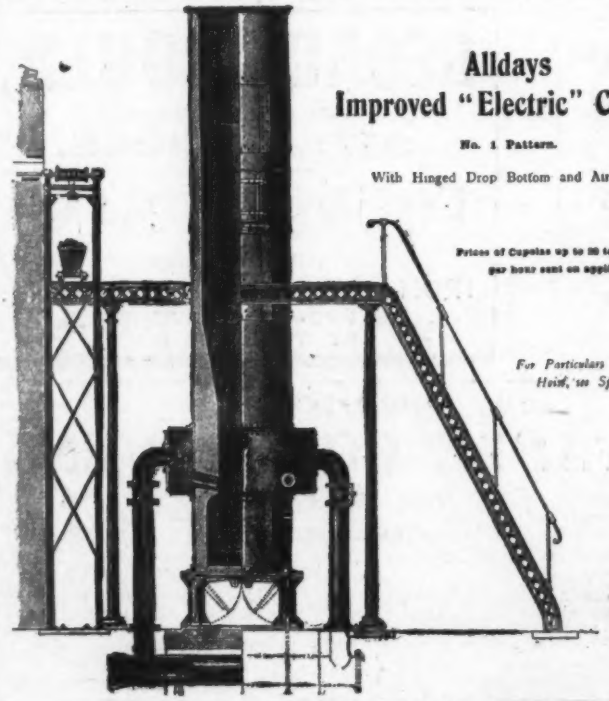
BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."



Alldays Improved "Electric" Cupola.

No. 1 Pattern.

With Hinged Drop Bottom and Air Belt.

Prices of Cupolas up to 30 tons capacity per hour sent on application.

For Particulars of Stage and Hoist, see Specification.

FOUNDRY EQUIPMENT.

"ELECTRIC" CUPOLAS.
ROOTS' BLOWERS.
FANS. CORE OVENS.
LADLES.
MOULDERS' TOOLS AND BELLOWS.
BRASS FURNACES, OIL AND COKE FIRED.

Ref. B. Dept.

Alldays & Onions P.E. Co., Ltd.,
Birmingham.

And at 58, HOLBORN VIADUCT, E.C.

FOUNDRY PLANT.

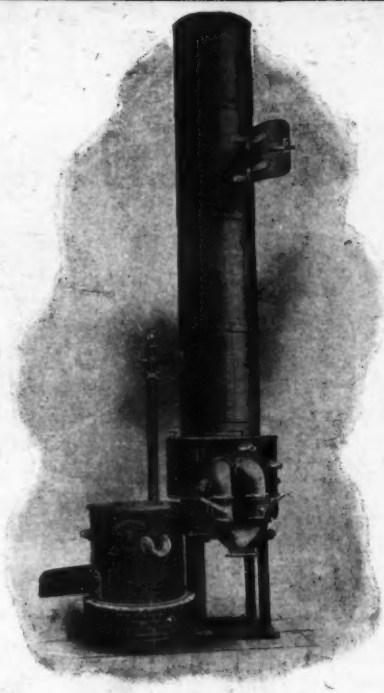
"Rapid" Cupolas,

with or without receivers or drop bottoms.

Roots' Blowers,

belt, steam-engine, or electro-motor driven.

Charging Platforms, Hoists, and Ladles.



ECONOMICAL RESULTS GUARANTEED.

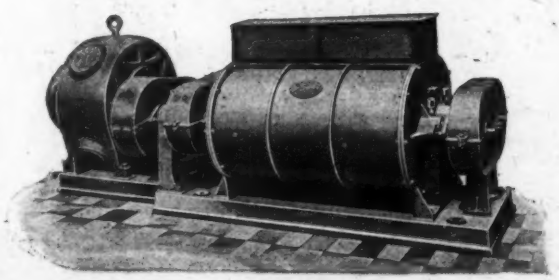
We are also Manufacturers of Steam Hammers, Smiths' Hearths, Centrifugal Pumps and Fans, High-Speed Engines, and the "Bradford" Patent Boiler Feed Pump.

We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

CONTRACTORS TO HIS MAJESTY'S GOVERNMENT.

THWAITES BROS., LTD.,

Vulcan Ironworks, BRADFORD.



Telegrams—
"THWAITES, BRADFORD."

Telephone—
No. 325 BRADFORD.

London Office:
96 & 98, Leadenhall Street, E.C.

Catalogues on Application.

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER

Telephone: "N° 2297 CENTRAL" MANCHESTER.

JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.